International Marine Engineering

APRIL, 1908.

THE FAST STEAMER FLORIDA.

BY GEORGE JENKINS AND A. E. WOODRUFF.

The *Florida* is the latest addition to the fleet of steamers of the Baltimore Steam Packet which run between Baltimore and Norfolk, and is said to be the finest and fastest vessel on Chesapeake Bay. She was built by the Maryland Steel Company, at Sparrows Point; is handsomely fitted out with passenger accommodation; contains 136 staterooms, and is the largest passenger vessel south of New York City.

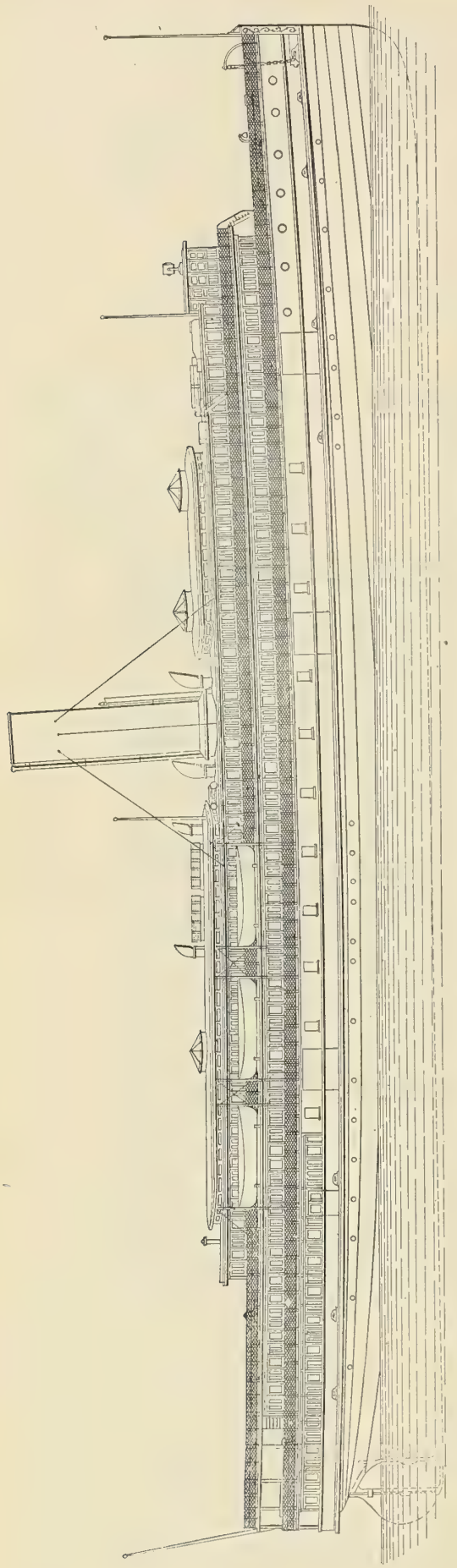
The *Florida* in construction and appearance is similar to the steamer *Virginia* of the same line, with the exception of the gallery deck, which extends the full length of the ship, and gives her thirty more staterooms. Her center keelson is 45 inches by 25 pounds and is connected to the frames by 22½-pound floors, reduced at ends. Under the engines the floors are 41 inches deep at the forward end, tapering aft to

THE INTERIOR DECORATION OF THE FLORIDA, AS TYPIFIED IN THE MAIN SALOON AND GALLERY.

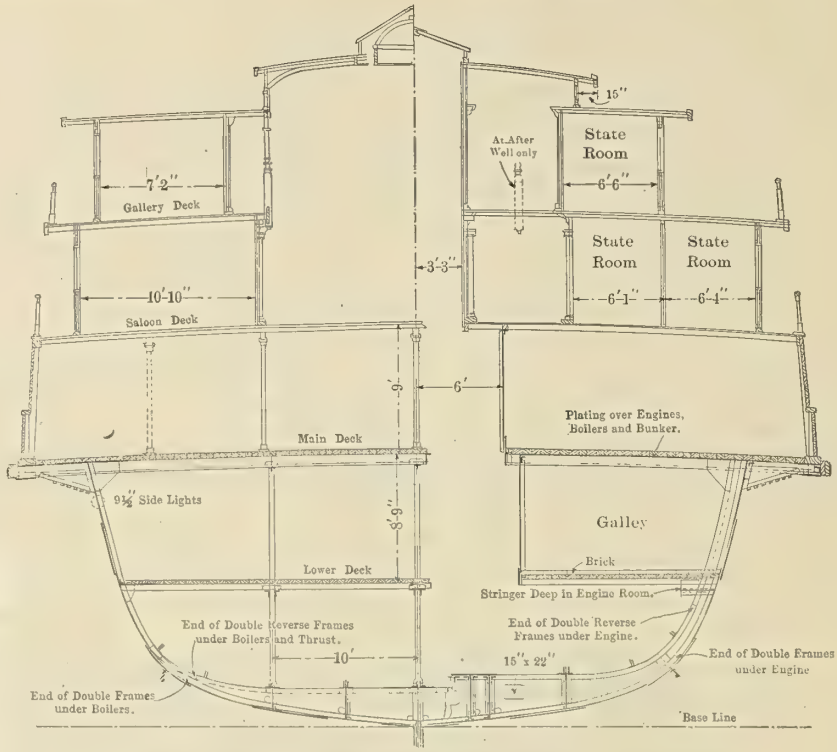
Her principal dimensions are:

Length over all	306 feet
Length between perpendiculars	296 feet 2 inches
Beam molded at waterline	41 feet
Beam molded at deck	45 feet
Beam over guards	66 feet
Depth molded	18 feet
Draft, mean	11 feet
Draft, forward	9 feet
Draft, aft	13 feet
Gross tonnage	2,200

follow the center line of the shaft. She is framed with angles 4 by 3 inches by 9.8 to 8.5 pounds, doubled at the forward end to give strength and protection for running in ice. In the engine space there is a belt on every frame to main deck; elsewhere, on every tenth frame. Her main deck beams are 9 by 3½ inches by 27 pounds, bulb angles, on alternate frames, and the lower deck beams are 5 by 3 inches by 9.8 pounds on every frame. Her main deck stringer is 50 inches by 22½ pounds, and the sheer strake is 27½ pounds, both reduced at ends. Seven watertight bulkheads running from the keel to the main deck divide the hull into eight watertight



OUTBOARD PROFILE OF THE NEW STEAMER FLORIDA, BUILT BY THE MARYLAND STEEL COMPANY.



MIDSHIP SECTION OF THE FLORIDA, WITH DETAILS OF UPPER WORKS.

compartments. Her scantling is a little in excess of the requirements of the United States Register for steel vessels, which gave her a rating of "A No. 1" for twenty years.

While some attention has been paid to speed, the greatest care has been bestowed upon the comfort and safety of passengers, and, being in excess of the rules, she is sufficiently strong to do her work with ease. This idea has been followed, because in practice it is not only economical, on account of small wear, but very durable, and also produces a vessel almost entirely void of vibration.

Besides 136 staterooms, there are accommodations for thirteen second-cabin men and fifteen second-cabin women on the lower deck forward. On the same deck is the dining room, finished in oak of an elaborate design, artistically decorated, and with a seating capacity for fifty-six passengers at one time.

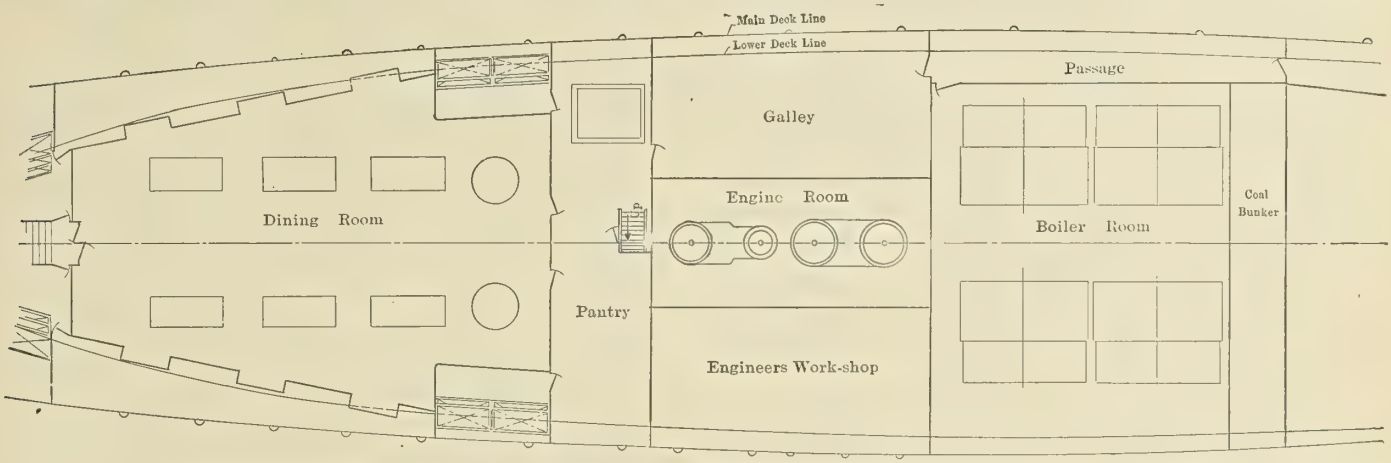
The main deck is chiefly for cargo and baggage, except the saloon aft, this being finished in quartered oak, and the social hall, which is finished in mahogany. The main gallery saloons are tastefully finished in soft wood and mahogany, the decorations being white and gold. One of the features of the *Florida* will be the domes in the gallery deck, which will be glazed with cathedral glass.

Interlocking rubber tiling is laid in the social hall, dining room, stairways and wash rooms. The staterooms are finished with velvet moquette carpets, all of the rooms having individual heat, light and electric bells, and the larger rooms having brass bedsteads.

MACHINERY.

The machinery consists of one four-cylinder, triple expansion engine, four single-ended Scotch boilers, a donkey boiler, an electric set and other auxiliary machinery. The main engine developed, on trial, 2,550 indicated horsepower on 105 revolutions per minute, with 175 pounds steam pressure, driving the boat at 17½ knots speed.

The two low-pressure cylinders are placed forward of the high-pressure cylinder, and the intermediate cylinder aft. This arrangement of cylinders was made for balancing purposes, and as the *Florida* has a night run entirely, it is

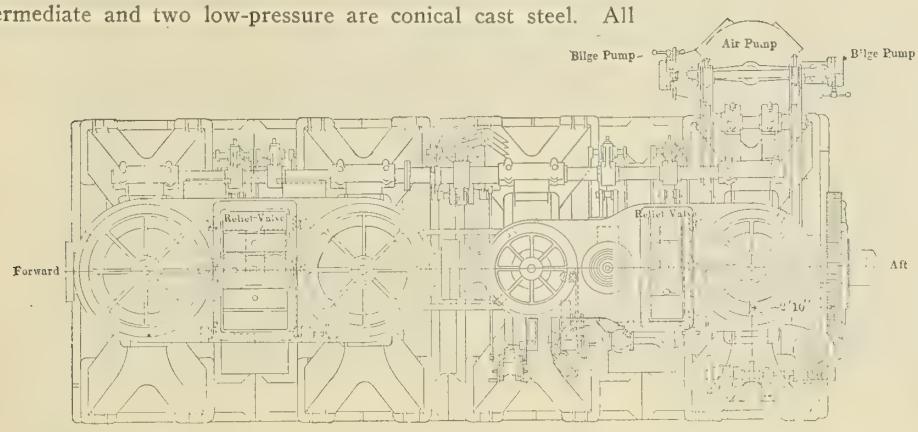


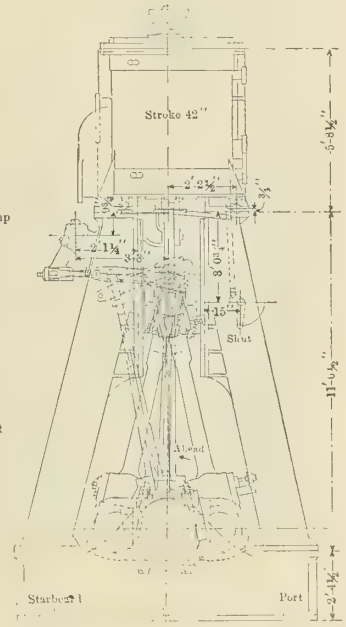
PLAN OF A PORTION OF THE LOWER DECK OF THE FLORIDA, SHOWING GENERAL ARRANGEMENT OF MACHINERY SPACES.

imperative that the engine should be as nearly balanced as possible.

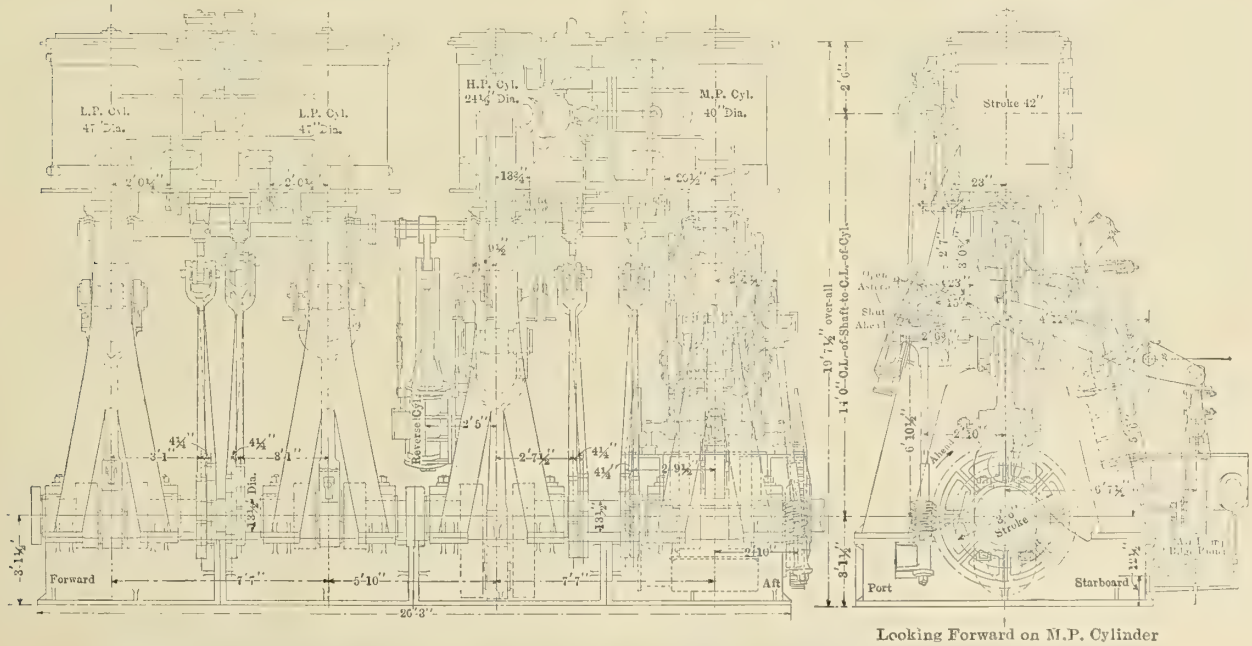
The high-pressure cylinder is fitted with a working liner of cast iron, and has an 11½-inch piston valve. The intermediate cylinder is fitted with a double ported slide valve, and the two low-pressure cylinders have double ported slide valves working in a common chamber.

The high-pressure piston is a solid iron casting; but the intermediate and two low-pressure are conical cast steel. All





Looking Aft on L.P. Cylinders



Looking Forward on M.P. Cylinder

PLAN AND LONGITUDINAL AND END ELEVATIONS OF THE FOUR-CYLINDER TRIPLE-EXPANSION ENGINE OF THE FLORIDA.

pistons have cast iron spring rings. The piston rods are of wrought steel, the low-pressure rods being 4½ inches in diameter, and the others 5 inches in diameter.

The connecting rods are of the strap-end type, with brass boxes top and bottom; the low-pressure rods being lighter than the others. The high-pressure and intermediate cross-head pins are 7 inches in diameter by 7⅛ inches long; the low-pressure cross-head pins are 6 inches in diameter by 6⅜ inches long. The cross-heads are of wrought steel, fitted to double cast-iron slippers faced with white metal.

Each cylinder is supported by two hollow, cast-iron columns, each having a hollow cross-head guide bolted to it. The bed plate is in four sections, with facing to receive the main bearing boxes. These boxes are made of hard brass, lined with white metal and secured by wrought-steel binders and bolts.

The valve gear is of the Stephenson link type, having wrought steel strap end, eccentric rods and drag links, steel links, pins, cast iron eccentric and straps, and brass eccentric rod boxes, drag link boxes and link blocks.

The reversing gear is a steam ram, 14 inches diameter by 24 inches stroke, secured to the after side of the high-pressure back column. The reverse shaft is in two parts, of wrought steel, with wrought steel arms. A 5 by 5-inch double-cylinder turning engine is secured to the forward side of the intermediate front column, and connected to the crankshaft by worm and wheel.

An air pump and two bilge pumps are worked from the intermediate cross-head. The air pump is 30 inches diameter by 14 inches stroke; and the bilge pumps are 4 inches diameter by 14 inches stroke.

The crankshaft is of the built-up type, in two sections, of fluid compressed steel, 13½ inches in diameter. The crank-pins are 13¾ inches in diameter by 12 inches long. The thrust shaft is 13½ inches diameter, of fluid compressed steel, with six collars forged on. The thrust is taken on cast iron horse-shoes faced with white metal. These horseshoes are held in place by brass nuts on bronze rods, permitting an independent or collective adjustment of the horseshoes. All the line shafting is 13¼ inches; and the propeller shaft is 13½ inches in diameter, covered the entire length of the stern tube by brass sleeves.

The propeller is of the built-up type, with cast iron hub and composition blades. It is 12 feet 9 inches diameter, with a pitch adjustable from 18 feet 3 inches to 19 feet 3 inches (pitch ratio, 1.43 to 1.51).

The condenser is independent of the main engine, having a cast iron circular body, and containing about 3,700 square feet of cooling surface. The circulating pump is from the Kingsford Machine Company, having 12-inch suction, and driven by a vertical 9 by 9-inch engine. A 36-inch Reilly feed heater has been installed; and two 25-kilowatt General Electric direct-connected, multi-polar dynamos have also been fitted.

All pumps are of the Warren horizontal duplex type, and consist of the following: One feed pump, 12 by 7 by 12 inches; one donkey pump, 12 by 7 by 12 inches; one sanitary pump, 6 by 5¾ by 6 inches; one fresh water pump, 4½ by 3¾ by 4 inches, and one heater drain pump, 4½ by 2¾ by 4 inches.

There are four main boilers and one donkey boiler, having a working pressure of 175 pounds per square inch. The main boilers are of the single-ended Scotch type, 13 feet 2 inches mean diameter by 11 feet 3 inches long, having a total grate surface of 286 square feet, and total heating surface of 7,100 square feet (ratio 24.8 to 1). Each boiler contains three 44-inch corrugated Morison suspension furnaces, with a common combustion chamber. The donkey boiler is a return tubular dry-back, 7 feet 3 inches diameter by 6 feet long, containing one 44-inch Morison furnace. All pipe connections are copper or brass, making the machinery, as well as the hullwork, strong and durable.

THE NEW STEAMER FLORIDA, OF THE BALTIMORE STEAM PACKET COMPANY.

An Improved Winch.

An invention which is expected to have an important future has recently been made in Liverpool. The innovation in the winch consists in the adaptation of a sprocket and chain in place of the cog. It is said that this is the first time such a device has been applied to a steam winch. The main point seems to be a very marked decrease in the noise of operation. It is said that when lifting considerable weights there was a sort of rumble like that of a motor car, but a total absence of the nerve-racking rattle and crash associated with the operation of the ordinary steam winch. The driving chains were adjusted to a breaking strain of 15 tons, which is not far different from the shearing strains of the ordinary tooth-wheeled gear. It is said that the chains offer very great facilities for repair in case of necessity, particularly in comparison with the difficulty of repair to the ordinary type of winch.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

HEATING BY STEAM.

The arrangements for heating by steam are practically the same as those for reheating by hot water, with a few modifications, due to the difference between the flow of steam and hot water, and to the necessity for draining the condensed steam out of the heating appliances. The source of heat may be the same as with hot water, but arranged, where it is a boiler, to generate steam at low pressure, instead of merely to heat the water. On board ship, steam from the boilers is usually employed, reduced to the required pressure by one of the well-known forms of reducing valve. On shore, pressures of about 5 pounds per square inch gage are employed, and from that downwards. A very favorite form of heating is by exhaust steam, at below atmospheric pressure. As marine engineers hardly need reminding, the volume of steam and its latent heat per pound increase rapidly at pressures below the atmosphere, and in some forms of steam heating, pressures as low as 1 pound absolute per square inch, or even less, are employed. On board ship, pressures of from 15 to 25 pounds are more frequent, because of the inconvenience of reducing to much lower pressures.

Heating by steam also differs from heating by hot water, in the temperature of the heating appliance. Thus, with 15 pounds gage pressure the temperature of steam is about 250° F.; at 5 pounds gage pressure it is 228° F.; while, as explained, the usual temperature of the hot water employed in heating appliances is in the neighborhood of 170° F. With exhaust steam below atmospheric pressure, practically the same temperatures are obtainable as with hot water, and that is another advantage in its favor, apart from its economy. The temperature of steam at 6 pounds absolute is 170° F., and the latent heat is 994.7 B. T. U. per pound; while at 15 pounds gage pressure it is only 938 units, and at 25 pounds gage pressure only 926. The higher temperatures of the heating appliances are in favor of the liberation of a larger quantity of heat per square foot of the heating appliances per hour, because of the larger difference of temperature between the surface of the heating appliance and that of the surrounding air, and again because of the peculiar feature mentioned above of the rapid increase of the rate at which heat is liberated, as the difference of temperature increases.

On the other hand, however, there are grave objections to heating by steam, and those objections have led to the adoption of hot water heating appliances on shore to a very much larger extent than steam heating. The objections are that the steam heating appliances are not so easily controlled as the hot water appliances, and also there is the constant danger of the temperature of the heating appliance rising to a figure which causes it to produce a smell, referred to by heating engineers usually as that of burnt air. It is probable that this is largely burnt dust. There is also probably some action going on between the highly heated surface of the radiator and the air, that is not present with lower temperatures. Where the temperature of the heating apparatus is maintained at about that of boiling water, at ordinary atmospheric pressures, steam heating appliances have presented no difficulty whatever, but steam pressures are sometimes not easily controlled. Where a number of appliances are worked from the same source of heat, and the supply of steam is shut off to any considerable portion of them, unless the supply at the source is also reduced, marine engineers will hardly need reminding, the pressure of the steam—and therefore its temperature—in the remaining portion will rise, and the results mentioned will be produced.

The heating appliances used with steam heating are the same as for hot water heating. In fact, many makers list their

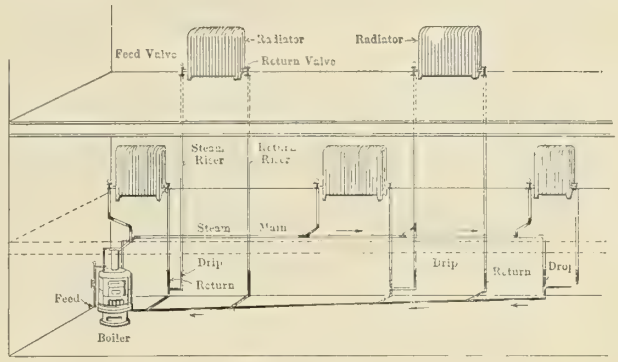


FIG. 16.—TWO-PIPE SYSTEM, LOW-PRESSURE STEAM.

radiators as applicable for steam or hot water. Pipes, of course, can also be used for steam or hot water, providing the sizes are in accordance. One or two points of difference have to be noted between the treatment of the two systems. With hot water distribution systems, the pipes are sloped where they are out of the vertical, so that the water will drain towards the boiler. With steam the pipes are sloped in the opposite direction, in order that any condensed water that is formed may be carried with the steam in the direction in which it is going, and may be driven out by the valve provided for it. Air is lighter than water, and therefore, as was explained, air cocks are to be fitted at the highest points of the service and at the tops of radiators. Air is heavier than steam, and therefore works its way downwards, and air cocks are therefore fitted at the bottom portion of radiators and in similar positions.

There are practically two systems of distribution of steam to the heating appliances, known respectively as the two-pipe and the single-pipe systems. In the two-pipe system the steam is carried to the radiator, and, with the condensed water that is formed, is carried away to some receptacle, from which it is pumped to the boiler, hot wells, etc. On the one-pipe system the steam is merely delivered to the radiator, and the condensed water that is formed is carried off from the radiator with the air that is driven out. Figs. 16 and 17 show the two-pipe and one-pipe systems as usually arranged. It is usual with steam systems to have lines of air pipes connected to the radiators, delivering the air that may have worked into the system with the steam, and that has to be driven out. This air is forced by the pressure of the steam out of the radiator through the air lines and discharged at a point where it will be harmless. Where exhaust steam is employed, it is usual to employ also a vacuum pump on the return pipes of the system, to bring the condensed steam and air back from the radiators.

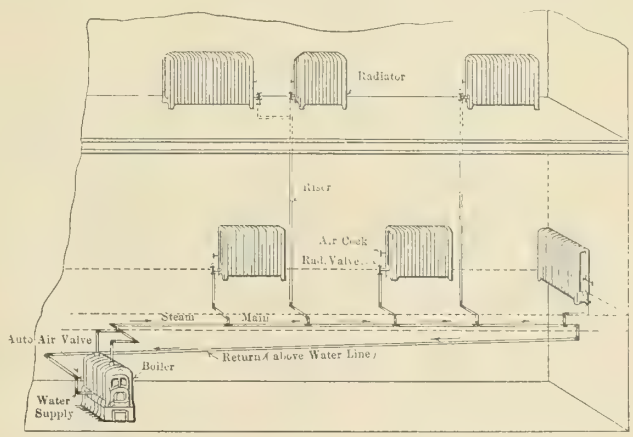


FIG. 17.—ONE-PIPE CIRCUIT SYSTEM, LOW-PRESSURE STEAM.

KORTING'S LOW-PRESSURE STEAM-HEATING APPARATUS.

Messrs. Korting Brothers, of Germany, who have made a close study of heating apparatus generally, have worked out a special system of low-pressure steam heating, which will be described. The steam is generated in a special boiler at a pressure not exceeding 1½ pounds per square inch, but presumably ordinary steam can be employed, providing that the reducing valve is arranged to lower the pressure to that figure. The very low pressure of operation is provided to meet the objection mentioned above, to the smell that sometimes arises from steam-heating apparatus, owing to the burnt dirt and burnt air with apparatus at high temperatures. A diagram of this is shown in Fig. 18.

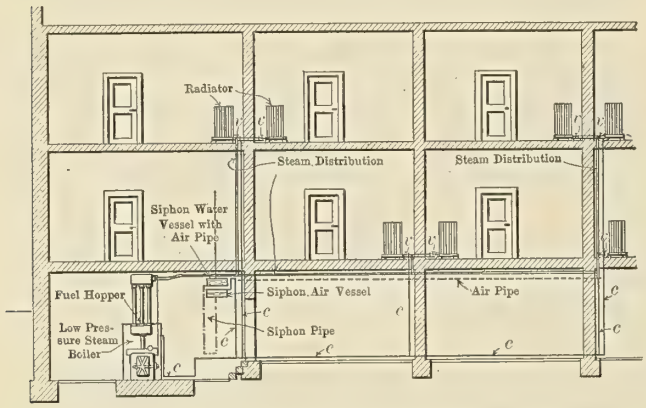


FIG. 18.—KORTING'S LOW-PRESSURE STEAM-HEATING SYSTEM AS APPLIED TO A HOUSE.

c, Return Pipes for Water. *v*, Steam Admission Valves.

For use with exhaust steam, an apparatus is employed in which the reducing valve is controlled by a lever, operated by a float working against a spring, the position of the float in the vessel being regulated by the pressure of the steam supply. When the pressure of the steam supply rises, the water in the vessel in which the float moves is driven downwards through the pipe at the bottom into another vessel at the side, whose position can be adjusted, the float then falling and partially closing the valve; the reverse operation taking place if the steam pressure falls. Where steam is supplied from the special boiler, the draft of the furnace is controlled by the temperature of the steam; a slight increase of temperature partially closing the furnace damper, and vice versa. It is doubtful whether, under ordinary conditions of sea-going ships, such apparatus would be desirable, but in sailing ships and in yachts, and in some classes of ships, such as whalers, sealers, etc., where the travel of the ship at times is not great, it might be convenient to have an apparatus of this kind.

A COMBINED AIR AND STEAM RADIATOR.

Messrs. Korting have also introduced a radiator, in which the steam is cooled by the presence of a certain quantity of air. Steam, it will be remembered, unless it is supplied below atmospheric pressure, must be at or above 212° F., and this is a somewhat high temperature under certain conditions. The temperature may be lowered by employing the partial vacuum method, but it is also claimed by Messrs. Korting that it is lowered in their special radiators by the addition of air.

The radiator is of the usual form, with a steam pipe running along the bottom of the sections, and at each section a steam nozzle enters the pipe. The admission of steam is controlled by the valve at the entrance to the radiator, in the usual way, and the steam passing out of the nozzle is allowed to draw air in with it, on the well-known injector principle. It is claimed that the steam mixes with the air, the former being cooled thereby, and the outside temperature of the radiator being consequently lowered, the air and steam circulating together, and the condensed steam being drawn off in the usual way.

(*To be continued.*)

The Relative Values of Warships.

BY C. T. BRADY, JR.

Whenever there is a prospect of war (or a newspaper prospect of one), or any unusual naval demonstration, some one is sure to make a paper comparison of the ships concerned. Sometimes these are interesting, but usually so many points are not taken into account, or else are so improperly weighted, as to be nearly worthless. Evidently some rational method would be useful. At the outset it may be clearly stated that such comparisons can be made only by a disinterested naval expert, with any hope of approximation, and also that no formula can be relied upon to do it very closely.

Still, to paraphrase M. de Voltaire, most of us are "neither disinterested, nor naval, nor experts," and yet we may be curious as to the strength of two opposing vessels. It is, then, the writer's purpose to derive here a formula which he has used with considerable interest in many cases, and found to agree very fairly well with results given by an English naval* authority's system of arbitrarily assigned values, with the *Dreadnought* as a unit.

First, we must state the requirements our formula is expected to fulfil. It must be simple and easy for a layman to apply; it must take into account as many of the features of the ship as possible; it must require no data usually not given in a newspaper description of the ship; and finally, it will be useful to have the value of the formula equal to 10, for a perfect or ideal vessel. The effect of four main characteristics will be considered, and there will be four terms in our formula, to be added together to give what may be called the fighting value of the vessel in question.

Nowadays we are coming to the conclusion that the primary aim of the fighting ship is to fight, and that fighting power is gained chiefly from large guns and plenty of them. From present tendencies, a battery of twelve 12-inch guns is none too high to be considered as ideal. Now it seems to the writer that at least 40 percent of a ship's value for warfare lies in her battery; hence if 10 is to be the total value of the type ship, 40 percent of 10 will be 4; and if we divide the ideal number of 12-inch guns by 3 we get 4. Accordingly, the first term of the formula is "the number, or equivalent number, of 12-inch guns, divided by 3." The equivalent number of guns can be readily taken from the appended curve, the data for the plotting of which was taken as follows: Fifteen 5-inch, nine 6-inch, six 7-inch, four 8-inch, two and one-half 9-inch, and one and one-half 10-inch guns, are equivalent to one 12-inch. These represent the number of guns of the lesser calibers which, in one discharge, will produce the same muzzle energy as one 12-inch. It is impossible to compare guns of different sizes in any way with accuracy, but this method is a fairly logical one, at least.

The second term of our formula is "the displacement in units of 10,000 tons." Many qualities, some of them intangible to rule, depend on the size of a ship. Steadiness of platform in a seaway, ability to keep the sea in times of storm, the amount of stores and ammunition carried, and finally the radius of action, are direct functions of the displacement. Twenty-five thousand tons is what we might expect for our ideal ship, and it would represent 2.5 or 25 percent in the ship's value.

*F. T. Jane: *Fighting Ships.*

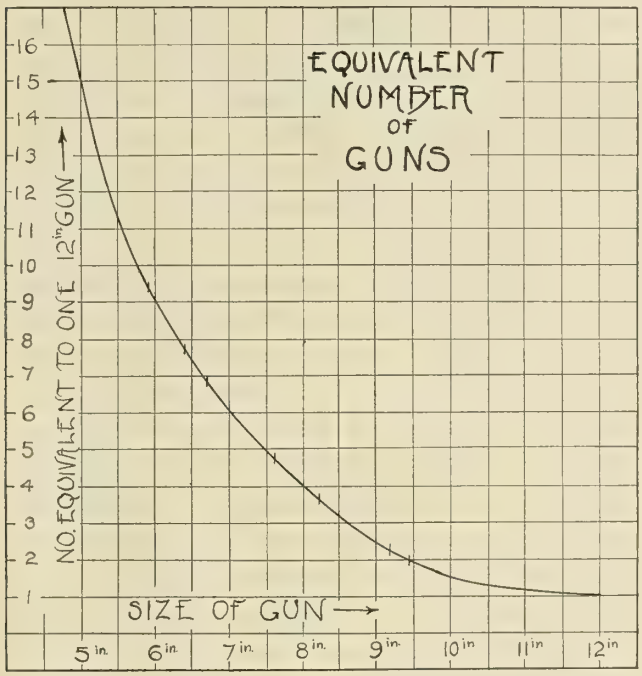


DIAGRAM ILLUSTRATING RELATIVE MUZZLE ENERGIES OF NAVAL GUNS.

Speed is of great importance in modern tactics. It seems, too, that the relative speed is not so important as the actual difference in knots. The third term of the formula is "the speed in knots, minus 15, and divided by 5." If our perfect type have a speed of 25 knots, this will represent 2, or 20 percent in the formula.

Adding together 4, 2.5 and 2, we have 8.5 so far for the value of the ideal ship; hence our last term, to bring this value to 10, must be 1.5. Now, 12 inches of belt armor is a good standard, and if we divide this by 8 we get 1.5. The last term is, then, "the thickness of armor on the belt, divided by 8."

Since ships deteriorate rapidly with age, and because of the advance in the quality of guns and armor, it will be logical to take only 0.7 of the formula value for ships launched between 1893 and 1900, and only 0.5 for those launched between 1885 and 1893. Ships built before 1885 will not be worth considering.

All this sounds very complicated, but the application is very simple. Symbolized, we have as follows:

$$FV = \frac{\text{12-inch guns}}{3} + \frac{\text{Displ.}}{10{,}000} + \frac{\text{Speed} - 15}{5} + \frac{\text{Belt armor}}{8}$$

The table gives values for typical ships by this formula. They are believed to be quite approximate in the majority of cases. In any event it is the first published attempt, so far as the author knows, which will aid the non-technical person in "guessing" at the values of two contrasted ships. The reader may hesitate to use it, through fancied difficulty, but if he will only try it on the first interesting case at hand, its essential simplicity will be apparent. To show the speed with which it may be applied, the writer may state that the table took him just one-half hour to complete.

Ship.	Nation.	Launched.	Guns.(a)	Tons.(b)	Speed.(c)	Armor.	F. V.
Michigan	U. S. A.	1908	8.0	1.6	3.5	11.	6.4
Connecticut	"	1904	8.0	1.6	3.	11.	6.3
Georgia	"	1904	7.3	1.5	4.	11.	6.1
Maine	"	1901	5.8	1.3	3.	11.	5.2
Mississippi	"	1905	7.3	1.3	2.	9.	5.2
Alabama	"	1898	5.6	1.2	1.	16.5	3.8
Kearsarge	"	1898	6.0	1.2	1.	16.5	3.9
Iowa	"	1896	6.0	1.1	1.5	14.	3.6
Oregon	"	1893	6.4	1.1	1.	18.	2.8
Kashima	Japan	1905	8.0	1.6	3.	9.	6.0
Mikasa	"	1900	5.6	1.5	3.	14.	4.4
Tsukuba	"	1905	5.5	1.6	5.5	7.	5.4
Dreadnought	England	1906	10.0	1.8	5.5	11.	7.6
King Edward VII	"	1903	7.1	1.6	3.5	9.	5.6
Inflexible	"	1907	8.0	1.7	10.	7.	7.2
Danton	France	1908	10.0	1.8	4.	11.	7.3
Republique	"	1902	7.0	1.5	3.	11.	5.6
Deutschland	Germany	1904	5.3	1.3	3.	9.4	4.9
Regina Elena	Italy	1904	5.0	1.25	7.	9.8	5.5
*Washington**	U. S. A.	1905	4.5	1.5	7.	5.	5.0
*California**	"	1904	2.6	1.3	7.	6.	4.3
*Black Prince**	England	1904	4.1	1.4	7.	6.	4.9
*Renan**	France	1906	2.6	1.4	8.5	6.7	4.8

* Armored cruisers; others are battleships. (*a*) Equivalent number of 12-inch guns. (*b*) Units of 10,000. (*c*) Excess over 15 knots.

Editor's Note.—Whatever scheme is put forward for the determination of approximate relative values of warships, there are always flaws, more or less glaring, which can be picked in it, and, as a general rule, the simpler the formula, the more glaring are the flaws. Without detracting in any sense from the value of the above method for such computations, a few points might be mentioned which would indicate somewhat the character of these flaws, and the points in which all such methods are more or less deficient.

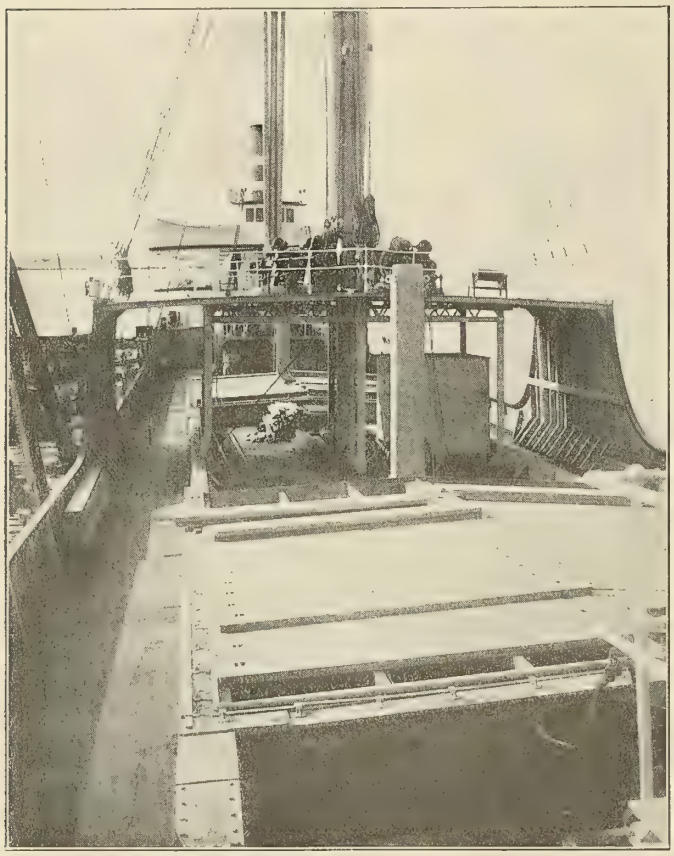
In the first place, a casual inspection determines the fact that the entire formula is empirical, the different military features being arbitrarily assigned values which may or may not meet the ideas of other investigators in the same field. Another point to which exception might be taken is in the distribution of relative values to the different guns. In the present case, these values vary about as the weights of projectiles fired from these guns. Some might object to this on the ground that it does not take due account of the greater rapidity of fire of the smaller guns; others might take the opposite view, and declare that it does not take into proper consideration the relatively much superior power of the heavier guns at long battle ranges. By taking the median position, as has been done above, the best general results have probably been attained, especially in view of the fact that great simplicity and ease of operation were prime requisites.

The question of armor is one which would probably cause more dissension than in the other cases above cited. In the present formula the maximum thickness of the waterline belt is all that is used, and a short, narrow belt thus receives the same approximate military value as would a belt of double its length and width. Here, again, the question of simplicity obtrudes itself, and points to the desirability of using the formula as given, instead of attempting to further complicate it by taking account of more items. The quality of the armor is not taken account of in any way, except in the general coefficient depending upon the age of the ship. This, again, is only roughly approximate, but it is exceedingly easy of application, and as such commends itself to consideration.

In considering the question of battery, it is usually held by naval strategists, their views being based upon all the naval engagements of the Spanish-American and Russo-Japanese wars, that the broadside fire of a ship is bound, in the future, to be that which will be most in use under all conditions of service. Bow fire is available only in contingencies, and almost never in ordinary fleet formations; for this reason, it might be suggested, that for the total guns of a given ship, there should be substituted, in the formula, simply those which can be brought to bear upon one broadside. In many cases this would make little difference with the relative values of ships; but it might be mentioned in passing that it would bring the battery figure of the *Michigan,* with eight 12-inch guns all firing on one broadside, up to that of the *Dreadnought,* which has ten 12-inch guns, of which only eight can be brought to bear on one broadside.

STEAM LUMBER SCHOONERS FOR THE PACIFIC COAST.

There have just been built by the Newport News Shipbuilding & Dry Dock Company, on plans and specifications prepared by Edward S. Hough, of San Francisco, two steam schooners of unique design, intended for service in the transport of lumber along the Pacific coast of the United States. One of these schooners, the *George W. Fenwick*, was built to the order of the Hammond Lumber Company, while the *Nann Smith* was built for the C. A. Smith Timber Company. In general features the two vessels are exactly similar, but certain differences will be noted later.

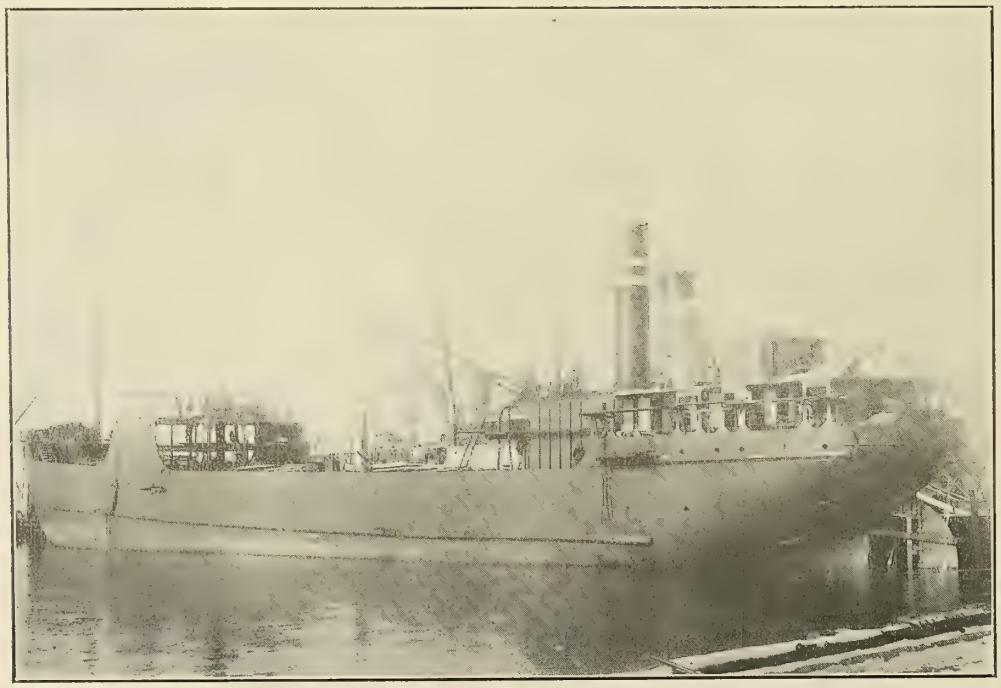


DECK VIEW, LOOKING AFT, ON THE NANN SMITH.

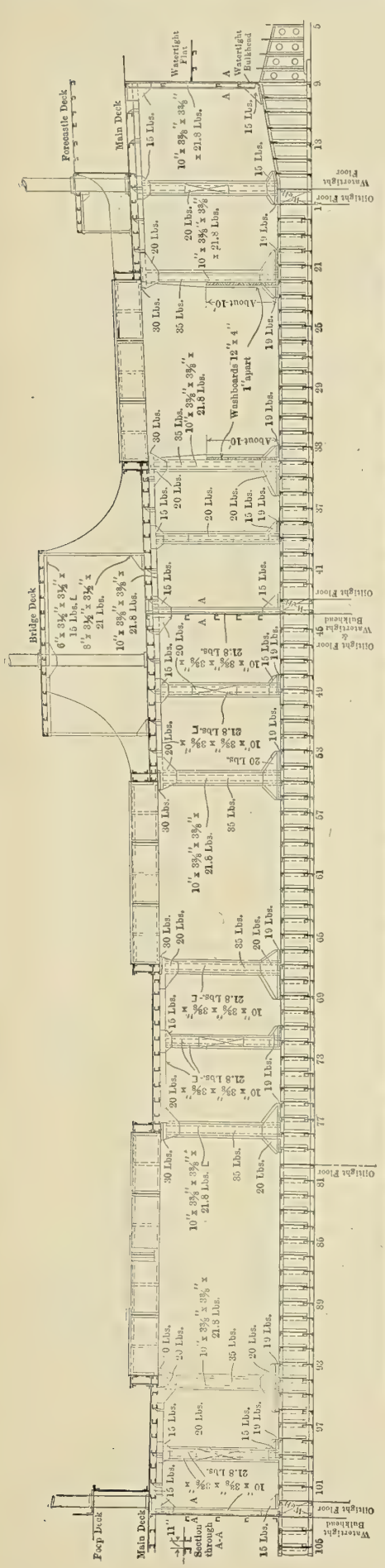
In each case the length over all is 295 feet 6 inches; the length under Bureau Veritas classification is 283 feet; the length between perpendiculars is 276 feet; the molded beam and depth are, respectively, 43 and 21 feet, with a double bottom 4 feet 6 inches deep at the center line, and 4 feet 3 inches molded at the sides. In each case poop and forecastle have been fitted with a height of 7 feet 6 inches, while the bridge has a height of 14 feet 6 inches above the main deck. The propelling machinery is at the extreme stern.

The vessels are built on the deep frame principle, so as to allow the lumber to lay up close and to avoid broken stowage. The double bottoms are of extra depth, and are made oil-tight, in order that fuel and freight oil may be carried. The tank top forward is raised 30 inches, in order to obtain continuity of strength. The forward hold above the tank top is arranged for the carrying of oil as water ballast, arrangements being made for shifting swash boards, which may be easily installed and removed. This feature is unusual in sea-going practice, although loose water ballast has been known for some time on the Great Lakes. It was adopted in this case because the two vessels will usually make the northward trip light, against frequently heavy winds and seas, which would cause distress on the comparatively flat bottom unless a sufficient immersion were provided to prevent pounding. For a distance of 50 feet from the stem the intercostal work of the double bottom has been made extra strong on this account. The keel plate is very wide and is treble riveted for the full length.

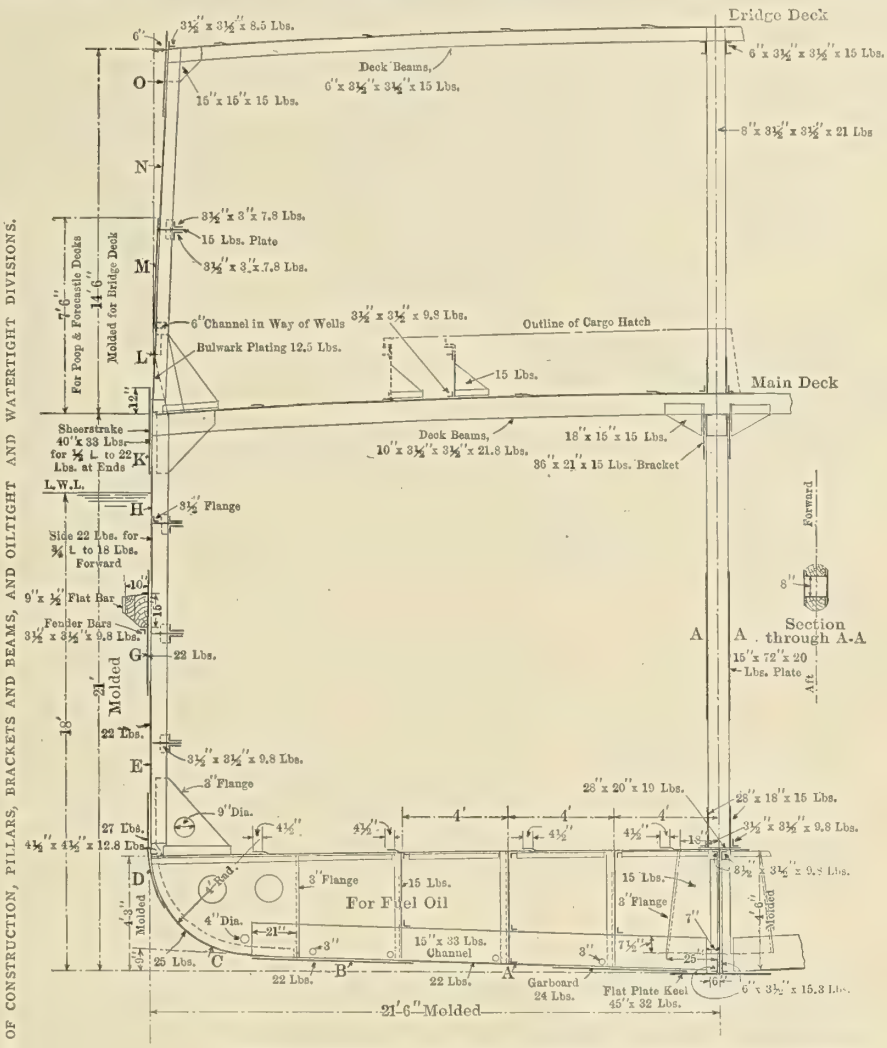
The cargo hatches are very much longer and wider than in the case of previous vessels on the Pacific coast. The decks are provided with continuous girders fore and aft, being of single plate between the hatches and box girders abreast the hatches. This arrangement gives great strength and first class compensation. The *Smith* has eight cargo winches for two hatches, while the *Fenwick* has only six for three hatches. All have been particularly designed for handling lumber.



THE STEAM SCHOONER GEORGE W. FENWICK, BUILT AT NEWPORT NEWS FOR PACIFIC SERVICE.



PARTIAL INBOARD PROFILE OF THE GEORGE W. FENWICK, SHOWING DETAILS OF CONSTRUCTION, PILLARS, BRACKETS AND BEAMS, AND OILTIGHT AND WATERTIGHT DIVISIONS.


Bridge Deck
Deck Beams, 6" x 3½" x 3½" x 15 Lbs.
15" x 15" x 15 Lbs.
8" x 3½" x 3½" x 21 Lbs
3½" x 3" x 7.8 Lbs.
15 Lbs. Plate
6" Channel in Way of Wells
Bulwark Plating 12.5 Lbs.
Outline of Cargo Hatch
Main Deck
Deck Beams, 10" x 3½" x 3½" x 21.8 Lbs.
18" x 15" x 15 Lbs.
36" x 21" x 15 Lbs. Bracket
Sheerstrake 40" x 33 Lbs. for ¼ L to 22 Lbs. at Ends
L.W.L.
3½" Flange
Side 22 Lbs. for ¾ L to 18 Lbs. Forward
9" x ½" Flat Bar
Fender Bars 3½" x 3½" x 9.8 Lbs.
22 Lbs.
21' Molded
3" Flange
9" Dia.
27 Lbs.
4½" x 4½" x 12.8 Lbs.
For Fuel Oil
4" Dia.
15" x 33 Lbs. Channel
Garboard 24 Lbs.
Flat Plate Keel 45" x 32 Lbs.
21'-6" Molded
Forward
Section through A-A
15" x 72" x 20 Lbs. Plate
Aft

MIDSHIP SECTION OF THE STEAM SCHOONERS, SHOWING SCANTLING DETAILS.

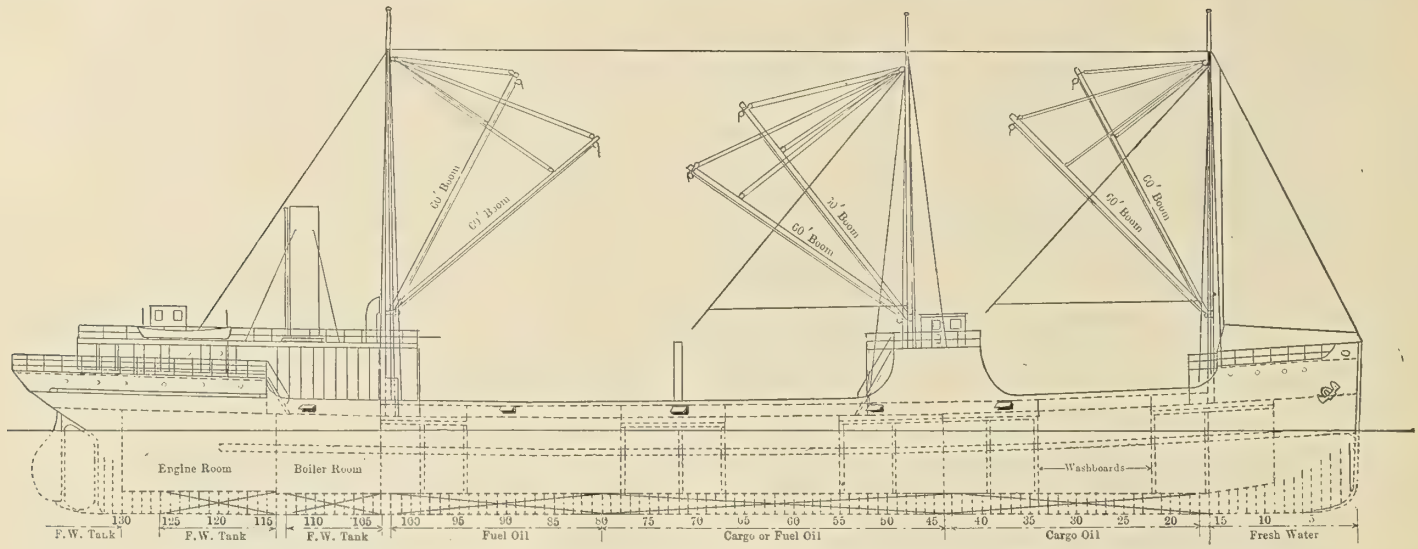
Both vessels are fitted with oil-burning systems, including two methods of atomizing the oil, one being by compressed air and the other by steam. The air pressure is 20 pounds per square inch.

The vessels are designed to carry about 2,250,000 board feet of lumber, weighing from 3 to 3.4 pounds per square foot, 1 inch thick. Assuming the average as 3.2 pounds, this makes a cargo of 3,213 tons. With this cargo, and with 2,000 barrels of fuel oil in the double bottom, the draft is 18 feet.

THE HULL.

The flat plate keel is 45 inches and of 32 pounds steel amidships. The garboard, bottom, bilge and side plates up to the main deck amidships vary from 22 to 27 pounds, with a sheer strake of 33 pounds, 40 inches wide. Above the sheer is bulwark plating of 12½ pounds, except in way of poop, forecastle and bridge deck. In the poop 14-pound plates are carried up the additional 7 feet 6 inches, while on the forecastle deck these plates are 16½ pounds; for the bridge deck, 14-pound plates are carried up over the 14 feet 6 inches above the molded main deck.

The solid continuous center line keelson is of 20½-pound steel, with double angles running along the top and bottom, and with angle clips joining it to the floors. Three side keelsons on each side, distant respectively 4 feet, 8 feet and 12 feet from the center line, consist of 15-pound plates fastened to the floors, the tank top plating and the transverse channel frames by angles measuring 3 by 3 inches by 7.2 pounds. The channel frame in the double bottom extends to the lower turn of the bilge and measures 15 inches by 33 pounds. It is

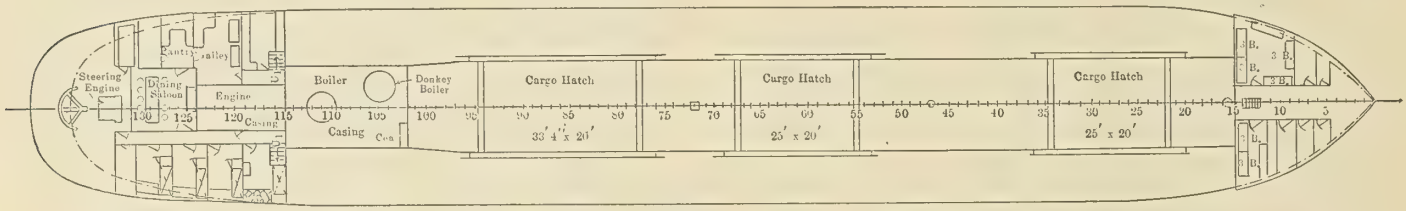


OUTBOARD AND PARTIAL INBOARD PROFILE OF THE GEORGE W. FENWICK, SHOWING OIL STORAGE, BOOMS, AND UNEQUALLY-SPACED MASTS.

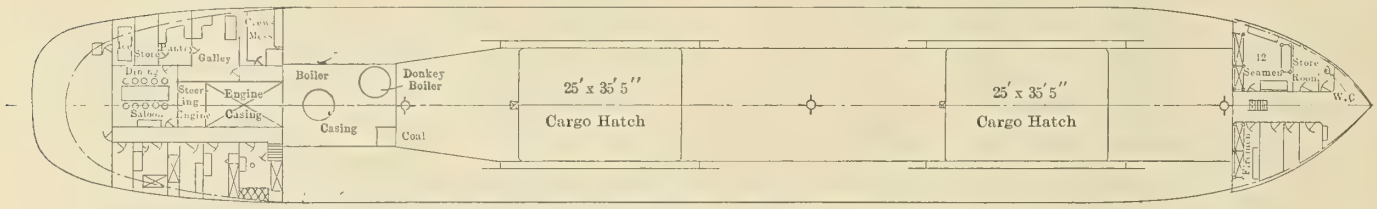
pierced in each compartment for 3-inch limber holes. At the ends are angle frames, 3½ by 3½ inches by 9.8 pounds. The bracket floors, which are located on every frame, are of 15-pound steel, with occasional lightening holes 12 inches in diameter. At the forward end the floors are 16½ pounds, and in the engine room 22 pounds. Around the turn of the bilge the outer edges of the floors are stiffened by short angle frames, 3½ by 3½ inches by 9.8 pounds. The bilge amidships is formed by the arc of a circle with a radius of 4 feet.

The inner bottom plating includes a center plate 19 pounds in the holds and 21½ pounds in the machinery space, with other strakes 14 pounds in the holds and 17½ pounds in the machinery space. The margin plates in the holds are 16½ pounds. This plating is connected to the floors by means of single angles measuring 3 by 3 inches by 7.2 pounds.

The transverse framing above the double bottom is entirely intercostal between the side stringers, the channels being 8 by 3½ by 3½ inches by 21 pounds, and spaced 25 inches apart. The side stringers, three in number on each side, consist in each case of a 15-pound plate 14 inches deep, and flanged 3½

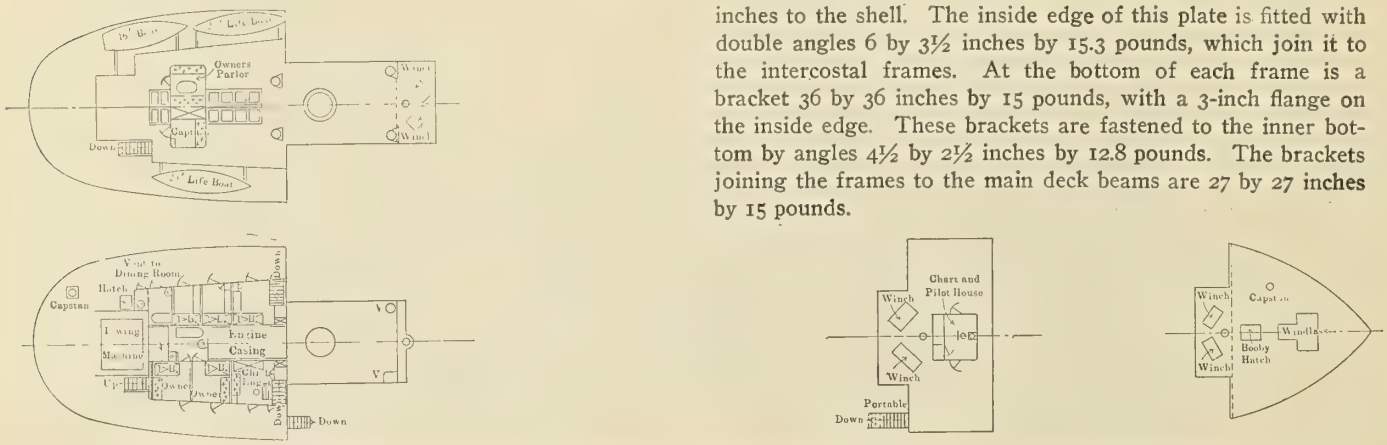


GENERAL ARRANGEMENT OF THE MAIN DECK ON THE GEORGE W. FENWICK, SHOWING THREE HATCHES, AND THE ACCOMMODATION FOR CREW.

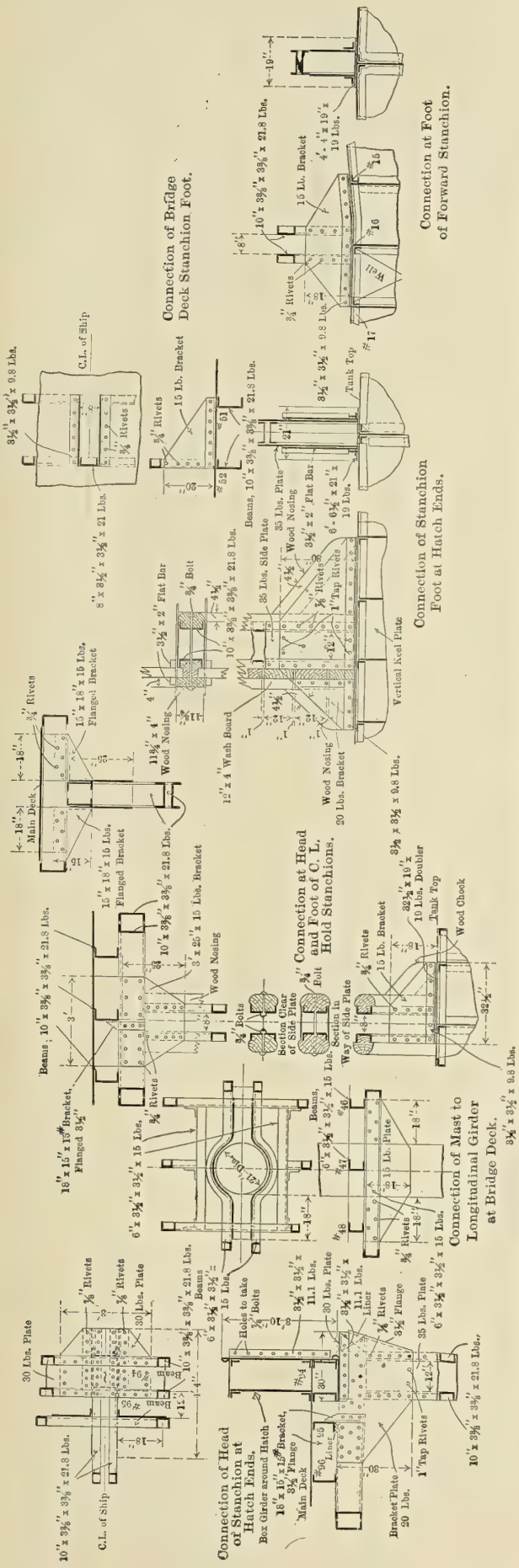


GENERAL ARRANGEMENT OF THE MAIN DECK ON THE NANN SMITH, SHOWING THE TWO LARGE HATCHES AND THREE EQUALLY-SPACED MASTS.

inches to the shell. The inside edge of this plate is fitted with double angles 6 by 3½ inches by 15.3 pounds, which join it to the intercostal frames. At the bottom of each frame is a bracket 36 by 36 inches by 15 pounds, with a 3-inch flange on the inside edge. These brackets are fastened to the inner bottom by angles 4½ by 2½ inches by 12.8 pounds. The brackets joining the frames to the main deck beams are 27 by 27 inches by 15 pounds.



GENERAL ARRANGEMENT OF THE POOP, FORECASTLE AND BRIDGE DECKS ON THE GEORGE W. FENWICK. THE NANN SMITH IS SIMILAR.


Connection of Bridge Deck Stanchion Foot.
Connection at Foot of Forward Stanchion.
Connection of Stanchion Foot at Hatch Ends.
Connection at Head and Foot of C. L. Hold Stanchions.
Connection of Mast to Longitudinal Girder at Bridge Deck.
Connection of Head or Stanchion at Hatch Ends.
C.L. of Ship
Main Deck
Tank Top
Wood Nosing
Wood Coaming
Vertical Keel Plate
Wash Board
Flanged Bracket
Box Girder around Hatch
Section Clear of Side Plate
Section in Way of Side Plate
Wood Chock

DETAILS OF CONNECTIONS ON THE TWO STEAM SCHOONERS, SHOWING THE GENERAL CONSTRUCTION, AND THE LIBERAL USE OF CHANNEL BARS FOR BEAMS AND GIRDERS.

Forward and aft of the collision bulkheads are frames consisting of angles 5 by 3½ inches by 10.4 pounds, with reverse frames 4 by 3 inches by 7.2 pounds. In the engine space the frames are also 5 by 3½ inches by 10.4 pounds, and the reverse frames are 6 by 3½ inches by 13½ pounds. In each case the spacing is 25 inches.

Above the main deck the frames in way of poop and forecastle decks are angles 5 by 3½ inches by 10.4 pounds, increased to 6 by 3½ inches by 13.5 pounds for the bridge deck. In each case a flanged bracket plate, 36 by 30 inches by 15 pounds, connects the frames by means of double angles, 3 by 3 inches by 7.2 pounds, to the main deck.

The main deck beams are channels measuring 10 by 3½ by 3½ inches by 21.8 pounds on every frame, with a spring of 10 inches in the beam of 43 feet. The bridge deck beams are channels fitted on every frame and with a spring of 10 inches. They measure 6 by 3½ by 3½ inches by 15 pounds.

The hold stanchions, or pillars, at the center line consist of vertical double channels, 10 by 3½ by 3½ inches by 21.8 pounds, with side plates at the midheight, 15 by 72 inches by 20 pounds, and wood filling pieces, as shown in the amidship section. These are fastened to the double bottom by means of brackets, 28 by 16 inches by 15 pounds, and angles, 3½ by 3½ inches by 9.8 pounds, with a doubling plate, 28 by 20 inches by 19 pounds, between foot of stanchions and centerplate of double bottom. A continuous horizontal girder just under the center of main deck beams is supported by these stanchions, and consists of double channels of the same size as used for the stanchions. The stanchions for bridge deck consist of channels, 8 by 3½ by 3½ inches by 21 pounds, with double longitudinals at the upper edge, 6 by 3½ by 3½ inches by 15 pounds.

The plating on the main deck measures 14 pounds, decreased to 11½ pounds at the ends, and increased in way of hatches. The stringer plate is 48 inches by 22 pounds, decreased to 31 inches by 17 pounds at the ends. On the poop and forecastle decks the plating is 15 pounds, flanged 3½ inches to the shell. On the bridge deck the plating is 12½ pounds, with 14-pound plate under the windlass. The stringer measures 22 inches by 14 pounds, decreased to 19 inches by 12½ pounds at the ends of poop and forecastle decks.

Bulkheads consist of plates of 13½ pounds, with single frame angles 5 by 5 inches by 14.3 pounds. The vertical stiffeners are angles 5 by 3½ inches by 10.4 pounds spaced 30 inches apart. Horizontal stiffeners of the same size are 4 feet apart.

The stem measures 10 by 3 inches. The stern frame is a separate forging, including a propeller post, 10½ by 6½ inches, and a rudder post 10 by 6 inches. The rudder has been arranged so that the pintle bushings can be renewed without raising the rudder; the latter may be shipped or unshipped while the vessel is afloat. The rudder stock and pintles are, respectively, 8¼ and 4¼ inches in diameter. There is no cementing in the double bottoms except where water is to be carried; but the forepeak, aftpeak and complete double bottom, as well as the forehold, are painted with bitumastic cement.

The hatches of the *Fenwick* are all 20 feet wide in the clear; the two forward ones measure 25 feet each in length, while the other is 33 feet 4 inches. On the *Smith* two hatches only are provided, these being each 25 feet wide and 35 feet 5 inches long. In each case the hatch includes girder coamings, 21 inches by 20 pounds, with angles at top and bottom, and with bracket plate stiffeners where necessary.

Each vessel has three masts, with fore-and-aft schooner rig. Each mast has wood cargo booms, six in all on the *Fenwick* and eight on the *Smith*, each 60 feet long and 12 inches in diameter at the center. The crew are accommodated in the forecastle, while the officers are in the poop; the galley and dining saloon are located also in the poop.

Complete pumping arrangements are provided for rapidly filling and discharging oil from the double bottoms, and ballast water from the holds, while ventilating pipes for the oil compartments are fitted equal in area to the filling pipes. In the wings of the boiler room are the evaporator and ice-plant equipment.

MACHINERY.

Each vessel has one screw operated by a triple-expansion engine, with cylinders 19, 31 and 52 inches in diameter, and a stroke of 40 inches. The low-pressure cylinder has a double-ported slide valve; the others have piston valves. At 90 revolutions per minute, the indicated horsepower is about 1,500. The connecting rod is 90 inches long. The condenser is built in with the frame of the engine. The crankshaft is in three interchangeable sections, 10½ inches in diameter. The crank pins are 10½ inches; thrust shaft, 10¼ inches; and propeller shaft, 11½ inches in diameter. The thrust bearing has water circulation.

The air pump, two bilge pumps and two feed pumps are attached to the back of the condenser, and are operated by a beam from the main engine. Both bilge pumps have connections to the double bottom and the sanitary pipes.

The evaporator, for making up losses of feed-water, has a capacity of 2,000 gallons per hour. The feed-water heater was supplied by the Griscom-Spencer Company, New York. The fuel-oil installation consists of a settling tank, air compressor, and the necessary piping, burners and furnace fronts. The air compressor is of the duplex, double-acting type, with steam and air cylinders 10 and 15 inches, respectively, in diameter, and 15 inches stroke. A duplex, horizontal, ballast pump, 14 by 18 inches, is also fitted.

There are two single-ended Scotch boilers, facing aft, with a total heating surface of 4,944 square feet and a grate surface of 130 square feet, giving a ratio of 38 to 1. Each boiler is 14 feet 6 inches in diameter and 11 feet 6 inches long and contains three furnaces. The steam pressure is 165 pounds per square inch, and the tubes are 3 inches in diameter. A vertical donkey boiler is fitted for the operation of winches.

The propeller is four-bladed, with a diameter and pitch of 13 feet each.

The cargo hoists have steam cylinders 8 by 8 inches, with piston reversing valve. An anchor windlass is fitted forward. Two steam capstans, 6 by 8 inches, one forward and one aft, are fitted with large drums. Steam steering gear (Hyde Windlass Company, Bath, Maine) is placed in the upper engine room, with hand steering gear as a relay. A steam towing machine (Chase Machine Company, Cleveland, Ohio) has cylinders 15 by 18 inches, the towing drum being fitted for 4½-inch cable. A small electric light plant has been furnished by B. F. Sturtevant Company, Hyde Park, Mass.

A Sub-Aqueous Rockcutter Dredger.

When addressing the Royal Society of Arts in January last on the constructive work of the Panama Canal, Mr. Bunau Varilla especially referred to the system of sub-aqueous rock cutting which has been perfected by Lobnitz & Company, Ltd., of Renfrew, near Glasgow. This system originated with a dredger which Messrs. Lobnitz constructed in 1887 for the Suez Canal, in which they introduced on the side of the well a series of hammers, or long needles, actuated by hydraulic rams carried on the framing for the bucket ladder. The object in view was to get rid of the slow and expensive process of boring sub-aqueous rocks for blasting, by means of diamond drills worked from barges on the surface.

After the experience gained with this Suez dredger the plant has been much improved, and as it is likely to be called into requisition for Panama, it is our purpose to describe here a rock cutter which Lobnitz & Company have just completed for operation on the River Blyth, Northumberland. The bed of this river is rock-post sandstone, and is extremely hard. Above the rock was a superincumbent mass of mud and clay, and this had to be removed and the rock bared. Under the old system the next process would have been to drill holes into the rock and then blast it; but a quicker and more economical method is now found in the Lobnitz rock cutter, which has some 500,000 cubic yards of material in Blyth harbor to remove.

The average depth of the harbor is about 16 feet at low water, and the project is to give it a uniform depth of 24 feet at low water and 39 feet at high water. The use of the rock cutter will, it is believed, save £70,000 ($340,000) in comparison with the older method of removing the rock.

There is a great ram, weighing 15 tons, working through a well in the center (or at one end) of a floating barge upon the rock beneath, which it splinters as a nut-cracker crushes a shell. The ram is very long, and has a hardened steel point. It is lifted by a steam winch with a steel rope, and, when at a sufficient height, a clutch is released and the winding drum whirls around very much like the free wheel of a bicycle, and the ram drops upon the rock, splintering it for a considerable radius. The position of the barge is calculated by sighting poles upon the quay, and is regulated by chains, so that, moving about in the river, it covers every inch of the ground. As the cutter proceeds, a dredger (in this case) follows immediately in its wake, and, scooping up the pulverized rock, carries it out to sea and there deposits it.

The rams or hammers in the Suez plant were square, first of forged iron and later of welded iron. They succeeded in breaking even the hardest rock satisfactorily, but the points suffered, and the renewal of the whole bar involved expense and delay. The introduction of the modern process of hardening steel solved this difficulty, and now the cutters, circular in section, are forged from one ingot of hardened steel, and have a removable ogival point, similar in form to that of large projectiles, and made of armor-piercing steel. In some cases in this plant a chisel-shaped point has been preferred for driving into tough rock, and in other cases a point with a series of tooth edges has been used, as in the case of one for the Irrawaddy river, where the current makes it difficult to insure that the blows would be successively struck on the same spot. There has been also important development in the plant to insure great exactitude in the point of contact of successive blows.

The cutter is a round bar of special mild steel, turned smooth in a lathe throughout its whole length. The diameter is thicker at the center of the length than at the two extremities. (The diameter at the center of a 12-ton cutter is about 20 inches.) The lower extremity is fitted with a cutting point fitted in a taper socket, so as to be easily replaced when worn. The top end of the cutter is fitted with a steel thimble, so constructed that the wire-rope is permanently attached to the cutter. The smallest size of cutter used is of 4 tons weight, 20 feet long, suitable for depths not exceeding 17 feet below high-water level. A 15-ton cutter is suitable for 50 feet depth.

The cutter is suspended over a pulley carried on the top of a tripod (or quadripod), the length of cutter and height of tripod being greater than the depth of water, so as to facilitate the guiding of the cutter, which passes through an aperture in a bearing located in the well of the barge, and fitted with springs to accommodate lateral movement or shock. The cutter thus falls vertically upon the same spot, special gear and moorings being fitted on the barge to prevent movement. The barge is maneuvered according to distance posts on the bank, so that each series of blows may fall upon a spot in the rock as marked on a chart.

This rock-cutting machinery may, if more convenient, be mounted on two old barges joined together by logs of wood or steel girders, bolted across on top of their decks; and on

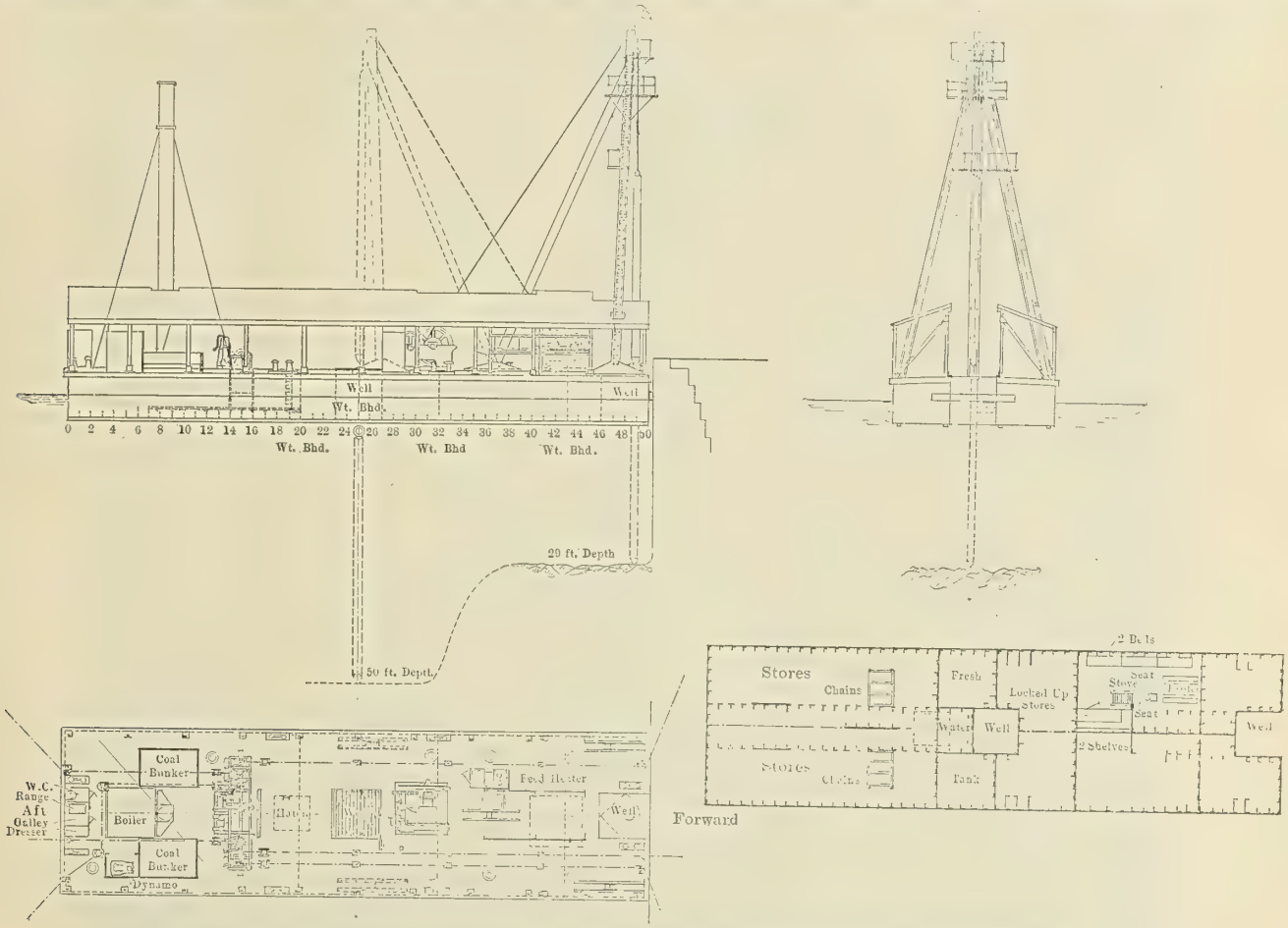
this foundation the rock-cutting machinery is erected. Some rock-cutting machines, however, are in use with one, two or three cutters working together, or a barge may be especially constructed for the machine, as has been done in the case at Blyth, which we illustrate.

With a drop of from 6 feet to 10 feet the cutter breaks its way into the surface of the rock, partly pulverizing it and partly breaking it. The whole force of impact is concentrated on a surface of a few square inches, and this enormous pressure will crush the hardest rock. The cutter is allowed to fall on the same spot until it has penetrated there to the depth desired. After this depth is attained, the barge on which the cutter is mounted is moved a distance of about 2 feet by means of the maneuvering chains, which are worked by a special steam winch designed to insure accuracy of movement. The cutter is then again brought into use until it has sunk into the rock to the desired depth. The barge is then again moved 2 feet, and so on. The cutter falls freely through a hole formed by a guide of steel or of hardwood, so fixed between upright timbers that it can be lifted by a steel wire hoisting rope, to vary the height of the guide according to the depth of water. When the depth of water is greatest the guide is lowered right down to the surface. The wire rope is of special construction, 5 inches in circumference for a 12-ton cutter.

The hoisting winch is a powerful steam engine with gearing and fittings to allow of continuous work. About 1,500 blows per day of ten hours may be given in regular work. It is so arranged with a steel friction clutch and automatic gear that the wire rope follows the fall of the cutter and raises the cutter again at once after the blow has been struck. A feed pump is worked from this winch, which feeds the boiler in proportion to the amount of steam used.

The maneuvering winch is an important part of the machinery. Six maneuvering chains are used. The four side chains are used to traverse the work, delivering blows in a straight line the whole width of the channel and spaced about two feet or more apart according to the nature of the rock. The apparatus is then maneuvered in the opposite direction across the width of the channel. The maneuvering winch is so arranged that the amount of chain taken in on the one side is exactly equal to the amount of chain given out on the other side. The six barrels on the maneuvering winch are all independent. Smaller barrels are also provided, with a quicker speed, for rapidly warping by means of rope when desired.

Base lines are established on shore. On the barge which carries the rock cutter two vertical rods are mounted in slots in a frame. These rods can be moved into other slots spaced 2 feet apart, or whatever distance is desired between the blows



LOBNITZ ROCK BREAKER FOR PULVERIZING SUBMERGED ROCK SO THAT IT CAN BE HANDLED BY A DREDGER.

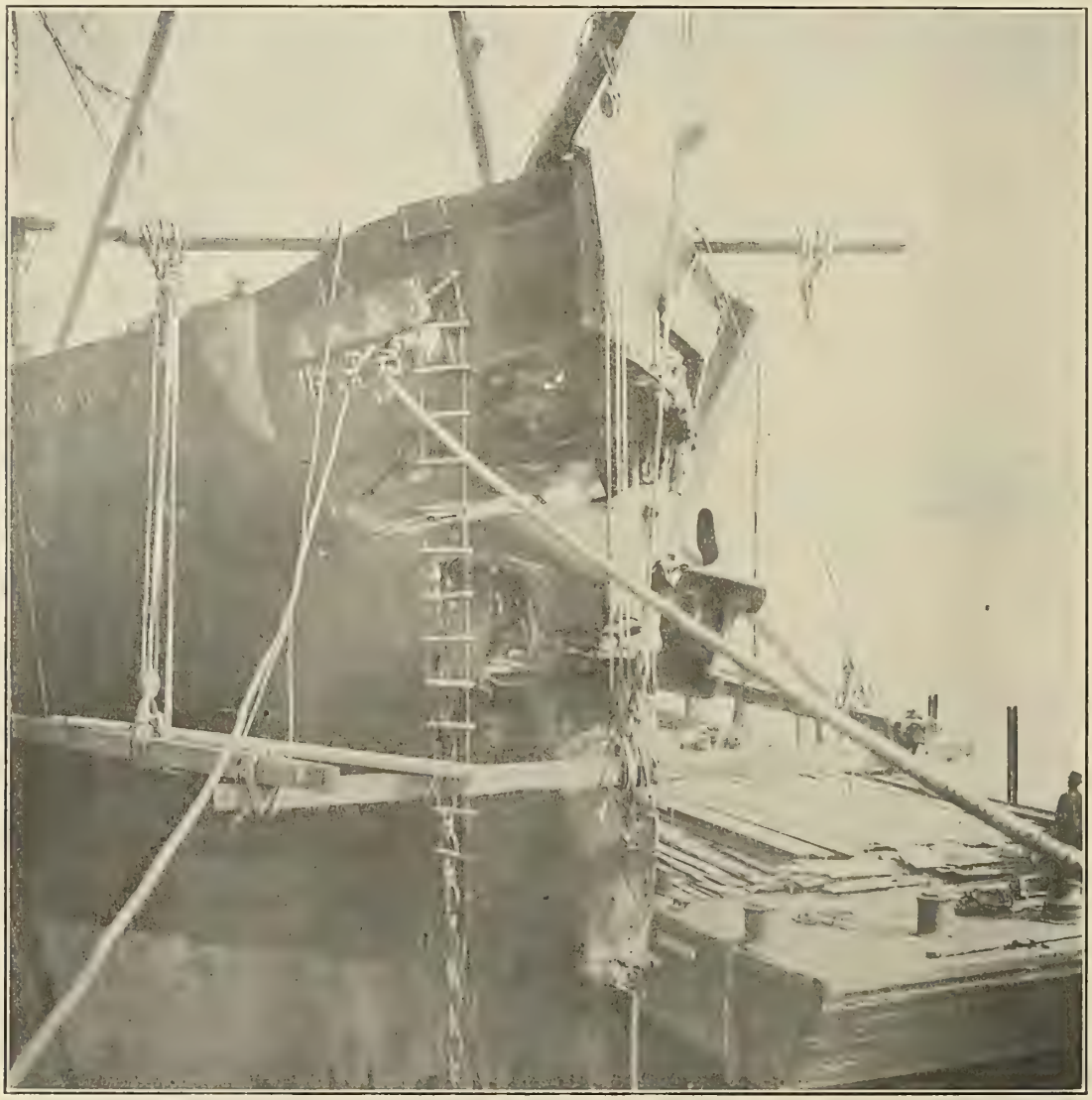
These two rods then form two sighting points, which can be sighted in line with two other rods ashore. The rods ashore are put up square to the base line, and the rods on board the rock-cutter barge are shifted 2 feet every time the barge is advanced, so that the rods on shore do not need to be moved every day. The distance from the base line is measured by means of a graduated wire.

The builders say that a much larger volume of rock can be broken when the blows are spaced more than two feet apart, but the advantage is entirely lost when the rock comes to be dredged; because when the rock is broken small it is dredged economically, whereas, breaking the rock into larger pieces makes the dredging more costly. One of the features of the rock-cutter system is that the lifting of the broken rock is as easy as ordinary dredging. When explosives are used to excavate rock the pieces are often large and costly to lift; whereas, the rock cutter leaves the debris broken small on an

even surface. A good bucket dredger scrapes the surface of the rock clean before commencing rock cutting, and afterwards removes the broken rock.

Excavation with these cutters is claimed to be more sure, less costly per cubic yard, and more rapid than by any other system known for sub-aqueous rock excavation. A single cutter machine will break up per day in average rock 100 cubic yards for 1 ton of coal and the wages of four men; and the cost of oil, stores and repairs should not exceed the expense for fuel and wages. Benjamin Taylor.

long, and forecastle 43 feet long. The officers', engineers' and passengers' accommodation is on the bridge, the saloon being tastefully fitted up in polished hardwoods, and the whole of this accommodation is heated by steam radiators. There is a most elaborate arrangement of deck machinery and derricks for the rapid handling of all kinds of cargo, and provision is made for dealing with lifts up to 25 tons weight. A complete electric light installation has been fitted, including clusters of lamps to provide illumination when loading or unloading at night, and a searchlight for use in the Suez Canal.



BOW VIEW OF THE STEAMSHIP HURONA, SHOWING DAMAGE DUE TO COLLISION.

A Record in Shipbuilding.

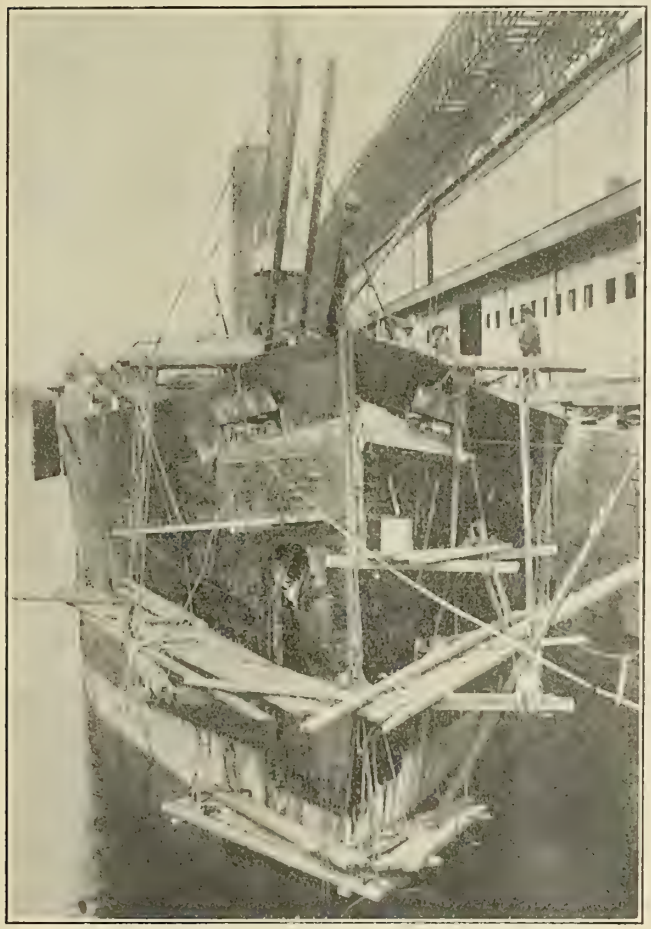
The 400-foot steamer *Blackwell* has just been built and launched at the North Sands Shipbuilding Yard, Sunderland, in the record time of sixty-nine working days. She was specially constructed to the order of the Tyzack & Bancroft Steamship Company, Ltd., and is designed for trading between Middlesbrough and London and Calcutta. The principal dimensions of the steamer are: Length over all, 417 feet; breadth, extreme, 50 feet 9 inches; depth, molded, 29 feet 9 inches.

The *Blackwell* has been constructed under Lloyd's special survey for their highest class on the spar deck rules and deep frame system, and has a poop 27 feet long, bridge 112 feet

Another Collision.

On Sept. 23 the Allan Line steamer *Mongolian* and the Thomson liner *Hurona* were in collision in the passage of Belle Isle, at the mouth of the St. Lawrence river. Both vessels were badly crushed at the bow, as our illustrations show, it being apparent that the *Hurona* struck the *Mongolian* just aft of the stem, and cut into her a great gash extending below the waterline. One illustration of the *Hurona* shows how the decks of the larger ship crumpled up the bows of the smaller, while the spaces between decks permitted the bows to enter with comparatively little opposition.

The *Mongolian* was in service between Montreal and Glasgow, was steaming eastward, and had on board a cargo of



TEMPORARY REPAIRS IN PROGRESS ON THE HURONA.

5,000 tons, consisting of grain and miscellaneous items, besides about forty passengers. The *Hurona* was en route to Montreal from Middlesbrough, with a full load of general cargo.

The Allan liner was built in 1891 by D. & W. Henderson & Company, of Glasgow. She is a steel screw schooner fitted with seven watertight bulkheads and with a double bottom for water ballast. With a length of 400 feet, she has a beam of 45 feet 2 inches, a depth of 30 feet 6 inches, and net and gross tonnages respectively of 3,088 and 4,838. Her triple expansion engine has cylinders measuring 30, 50 and 80 inches in diameter, with a stroke of 60 inches.

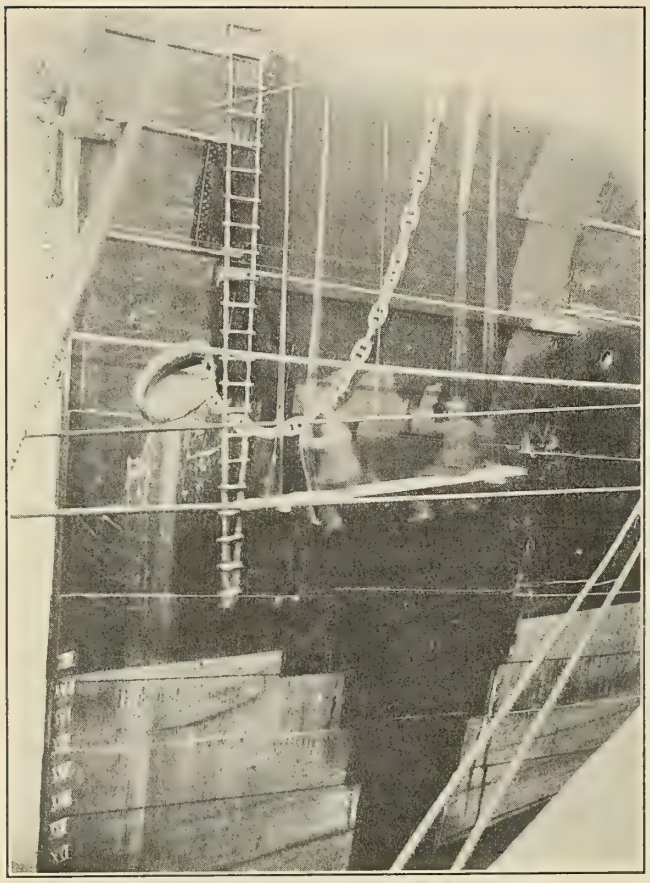
The *Hurona* was built at Barrow in 1892, and is a steel screw shelter deck schooner fitted with six bulkheads and with deep framing. She measures 360 feet in length, with a beam of 44 feet 6 inches and a depth of 23 feet 6 inches. Her net tonnage is 2,150, and 3,432 gross. The triple expansion engine has cylinders of 29, 44 and 71 inches, with a stroke of 54 inches.

Patched up sufficiently to stand the voyage across the Atlantic, and perhaps a good deal more, the *Hurona* has sailed for London. The work of repairing had been done expeditiously and well, and the ship looked fit enough for a lot of rough usage. The broken steel stem was built up of scantling and planks, strengthened by cement. This was then covered over with sheets of iron and painted black. One who did not know might not from her appearance even guess that she had been so badly smashed. She carried a heavy cargo for London, including grain and apples.

The photographs show where the decks of the *Mongolia* intercepted the bow of the *Hurona,* and tore great gashes.

THE HOLE IN THE SIDE OF THE MONGOLIAN.

SIDE VIEW, SHOWING DAMAGE TO BOW OF HURONA.



THE MONGOLIAN PATCHED UP AFTER THE COLLISION.

Reciprocating Versus the Turbine Engine.

In view of the rapid advance made by the turbine engine as the motive power for marine service, it will be interesting to review and note in a general way some of the salient points of the two types of engines, and consider them from a constructive standpoint, and not—as might be inferred from the title—on lines that will involve any of the theories regarding the distinctive features of either type; nor as to their relative economy or adaptability, or for the purpose which they were intended to fulfil; neither as regards the theory or action of the steam and the peculiarity of its flow, nor to take into consideration any of the numerous ideas advanced by those who have made an exhaustive study of the principles involved in the new type of steam motor. All of these features have been dealt with at great length by learned writers on the subject, and their views have been published in the leading technical journals of the day, and need not be considered further here; but more particularly the design, constructive details and the class of workmanship required in the building of the two types of engines, the superiority of which is apparent in the turbine type over that of the reciprocating.

When such comparison is made between the two types, one is amazed at the crudeness, one might say primitiveness, of the workmanship of the latter, as compared with that of the former, the reason for which is not far to seek. If it were not for the high degree of ingenuity and skill in adjustment, and refinement in workmanship required in the building of the turbine engine, it would be as nothing compared with that of the reciprocating type. Aside from special types of reciprocating engines, the marine engine for the merchant service is crude by comparison only. They are efficient and do their work economically to a very high degree. As a matter of fact, the best the turbine class can do is to equal it, but to the best of our present knowledge, never has the turbine engine much excelled the records made by the reciprocating engine. This question need not be considered further here, either, as this is not the part of the subject that we are concerned with at the present time.

The extent to which the refinement of machine work, the fitting and adjustment, is carried out to the minutest detail in the building of the turbine engine would not be considered for a moment by any builder of reciprocating engines; because of the costly methods, and as being uncalled for—not required—or as it might be expressed, "it would not pay." In the case of the turbine it is different. They have to be built that way, for, as said before, the turbine engine would be as nothing if built without such refinement in design and construction, in order to correct the inherent defects in this type of engine. Therefore, we will have to accept the proposition that such refinement is imperative, and is the price to be paid for accepting the turbine principle. Having accepted the inevitable, we then proceed to find ways and means to solve the problem, which has been successfully accomplished, and resulted in placing the turbine engine on a very high plane, showing what can be done by determination and persistent effort when applied in the right direction.

The broad statement is made in the foregoing that the reciprocating engine is a crude affair, as regards workmanship, when compared with that necessary in the construction of the turbine engine. And this fact is readily apparent on close examination of the two types of engines in marine service. Let us consider, in a comparable way, the rotor casing of the turbine, with that of the cylinder of the reciprocating type. The former are made up, in the larger sizes, of from four to six separate sections, and divided in two parts longitudinally, having the heads cast integral with the end sections of the casing, provided with openings through which the rotor shafts work, and fitted with packed bearing heads, not unlike the bottom cylinder head of the reciprocating type.

Of necessity, these casings are too great in dimensions to be made in one casting. At least they must be divided longitudinally to permit the placing of the rotor within the casing. The joints of the several sections must be carefully made and strongly bolted up, to which is added the fitting of the joint dividing the upper and lower part of the completed casing, a joint which must admit of repeated separating and closing, metal to metal, and steam tight under the working pressure. In addition, the casing goes through a process of rough boring and steam seasoning to the final finished boring and grooving, all of which has to be done with the casing bolted together, requiring special boring tools, and the offsets or grooves properly located by accurate measurements made from the outside in the smaller sizes, and from the inside on the larger sizes, all of which is a time consuming process, the like of which is never done on cylinders or any other parts in building reciprocating marine engines.

In the building up of the rotor, another time consuming element is the boring and fitting of the rotor onto the shaft, and the finished turning and grooving, all of which has to accurately conform to that of the casing. The co-efficient of expansion of the metals comprising the casing and rotor has to be considered carefully, and tried out to determine if the two parts will expand in length with the least difference, in order that the rotor blading will not foul that of the standing part in the casing. Then comes the tedious process of blading of both the rotor and casing, the different sizes and length of blading which must be inserted firmly and truly radially, and securely locked in place, all of which has to be done with the greatest care, down to the minutest detail. Then follows the balancing of the rotor, fitting and adjusting it into the casing and bearings, and providing micrometer adjustment longitudinally. Throughout the entire installation the greatest care

must be taken to insure a perfect working condition, to the last fraction of vacuum obtainable.

The separation of the casing for examination of the rotor is a matter of careful design and detail, that it may be lifted with safety and true from off the rotor, without fouling the blading; as it must be, when taking into consideration the great weight of the part to be handled—upwards of a hundred tons in large low-pressure units.

A complete summation of all the numerous details in connection with the building of the marine turbine engine, as we see it to-day, is too great to be considered further here. We have dwelt on the subject only to an extent that will enable a comparison to be made between the two types of engines, as regards their constructive details and refinement in workmanship, as displayed in the building of those of the turbine class, which have been shown to be of a special and costly nature, as is self-evident.

The reciprocating or piston engine of the marine type for the merchant service has its inherent defects in principle, as well as those of the turbine class for the same service, and not the least of these is the limitation of rotative and piston speeds. There are cylinder condensation, wire drawing of steam, large clearance spaces, besides other numerous defects to which the reciprocating class is heir. These, if eliminated in part at least, would place the reciprocating engine on a higher plane than that on which it stands at the present time, —that is, if the cost of such elimination is not considered, as it is evident it is not in the case of the turbine engine.

On just what lines the elimination would best be followed will be a matter of conjecture, and be determined wholly by experiment, as was done in the case of the turbine. If the problem is attacked with determination and a free hand as regards cost, a great deal could be accomplished, beyond question. The building of a 15,000-horsepower unit to try out would be a matter of no small cost, as we know, yet this was done in the case of the turbine. In the balancing problem of the piston engine, much has already been accomplished in the past few years, and the results are highly beneficial as regards higher rotative speeds and reduced vibration. As the crank shaft is one of the factors in the problem, it might be well to consider to what extent refined treatment would apply to this detail. Oil-tempered steel for shafts and pins is a step in that direction, without doubt, to which might be added the grinding of all bearing surfaces and the fitting of shafts in self-oiling journals, and following on the same lines the refined treatment to include all of the numerous details of parts comprising the completed unit.

It would be considered that the steam cylinders are not the least important to which the refined treatment be applied. It could include jacketing on the barrels and heads and their fitting with chilled or hardened steel liners, ground and polished to a high degree. The inside surfaces of the cylinder heads could be machined and highly polished, the same treatment to include the pistons—that is, both sides be machined and polished, then followed by the reduction of the clearance spaces to a minimum between cylinder heads and pistons, and between the cylinder and valve faces. Eliminate the rough cored surfaces of steam passages to the minimum, which could be obtained by placing all valves in the heads, and perhaps of the poppet type. Continuing the same treatment, it would include reheating receivers and an efficient system of drainage down to and including the air pumps and condensers, and the maximum vaccum obtainable, also an efficient system of self-lubrication that would be continuous and never failing. The same treatment would include the problem of compression, as a higher rotative speed and smoother turning effort would be one of the imperative requirements, and would necessarily be controlled from the exhaust side, as a matter of economy.

It will be considered, as a matter of course, that the conjectures as to what parts of the reciprocating marine engine are susceptible to such refined treatment of material and workmanship, as outlined, will be largely of a forecasting nature. But, nevertheless, some of the ideas referred to are actual facts, as we know, and just what beneficial results could be expected from the balance, and others that might be suggested by practical application, is largely problematical.

Without question, it will be accepted that steam cylinders fitted with liners of hard material, bored and ground truly cylindrical and parallel, having the surfaces highly polished, will have a lower coefficient of friction than they otherwise would have, and with the rough surfaces of pistons and cylinder heads machined true and polished, the clearance volume and absorbative capacity would be greatly reduced. The absorbative quality of rough cored and cast, as well as that of roughly machined surfaces of coarse soft cast iron, is known to be much greater than that of hard, close-grained polished metals, and the elimination of such defects would result in the reduction of the cylinder condensation to a large extent.

The greater accuracy of workmanship, as could be applied to the reciprocating engine, would affect and improve its working condition throughout. If accuracy of all bearing surfaces were proved and known, the running clearances could then be determined to a certainty, and adjustments made accordingly. Steam jacketed surfaces and reheating receivers have been used quite extensively in the marine service, but the question of their continued use involves economy of space, weight and efficiency; yet the highest economy of steam consumed per indicated horsepower has been obtained in connection with their use. Therefore, it is reasonable to assume that they are some of the factors in the problem, and should be so treated in this connection.

In dealing with both sides of the question only a small part, covering the details of each type, could be dwelt on, and that only in a comparable way; enough, however, to show the vast difference in the constructive methods of the two types of engines.

W. M.

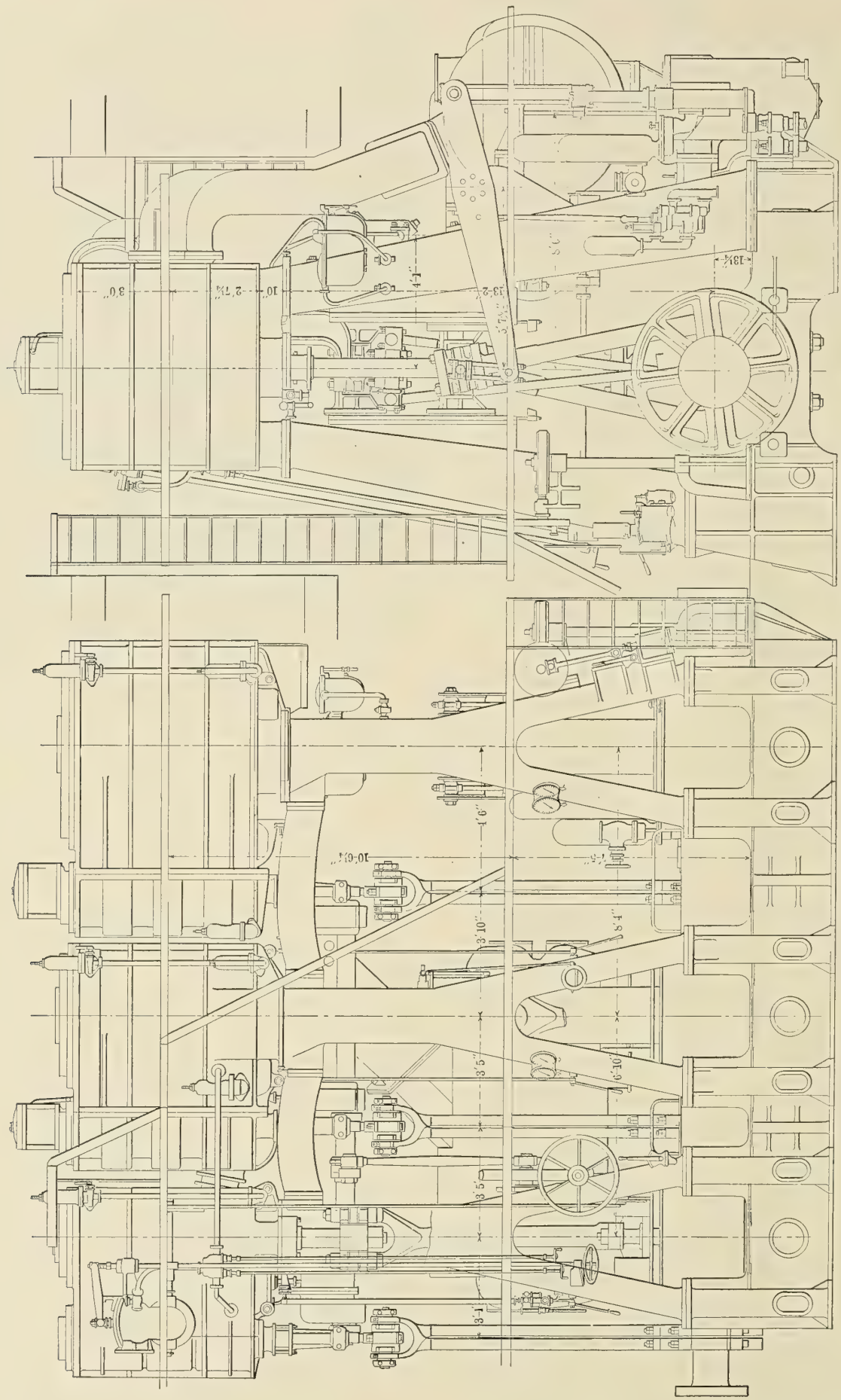
A Japanese Liner.

Messrs. D. & W. Henderson & Company, Limited, Partick, Glasgow, launched last April the steel screw steamer *Chikuzen Maru,* built for the Nippon Yusen Kaisha, of Japan. The dimensions of this vessel are: Length between perpendiculars 310 feet, breadth molded 40 feet, depth molded 26 feet 6 inches, with a gross tonnage of about 2,530. She has been built to class 100 A1 Lloyds spar-deck class, and also in accordance with the Teishinsho rules.

For first class passengers accommodation is provided in staterooms under the fore part of the bridge deck, and there are a dining saloon and smoke room in polished hardwood, of tasteful design. Accommodation for sixteen second class passengers is aft in the poop, with dining room, also in hardwood. Accommodation is provided in forward 'tween decks for third class passengers. Captain, officers and engineers are berthed amidships, and the seamen and firemen forward. Special attention has been paid to the accommodation, all the rooms being large, airy and well ventilated. The vessel is equipped with everything that can add to the comfort of passengers and to economical working of cargo.

The engine is triple expansion, with cylinders 25, 41 and 68 inches in diameter, and a stroke of 48 inches. The working pressure is 185 pounds per square inch. The cylinders are all separate, and the steam connection by pipes, with expansion joints to them. The columns are of the Y type in front, and rectangular at back, and all are tied together at the heads, making a rigid support for the cylinders. The bedplate is of the usual box construction.

The valve gear is of the Stephenson link motion, all



SIDE AND END ELEVATIONS OF THE TRIPLE-EXPANSION ENGINE ON THE JAPANESE STEAMER CHIKUZEN MARU, OF THE NIPPON YUSEN KAISHA.

adjustable, and the eccentric straps are of malleable iron, lined with brass. Steam reversing gear of the "all round" type is fitted, having machine cut gear. Steam turning gear is also fitted.

There are feed pumps driven by the air pump crosshead, also a pair of Weir's automatically controlled pumps, and one Weir feed heater. A suction feed filter (Carruthers make) is fitted between the hotwell and the engine feed pump. The condenser is a separate cylindrical casting, bolted to the two forward back columns. The air pump is driven from the low-pressure crosshead. The circulating pump, of ample size, is of the centrifugal type. Water service is provided through all the thrust shoes, the block being secured to the engine bedplate by forged iron palm ended bolts.

There are two single-ended multitubular boilers, 15 feet 6 inches in diameter by 11 feet 6 inches long, with three fires in each, arranged for forced combustion on the Howden system. The total grate area is 123 square feet, and the heating surface 5,113 square feet, making a ratio of 41.6 to 1. The funnel is provided with a telescopic piece where it joins the smokebox, the main funnel being carried by the beams of the vessel. A large donkey boiler is provided for the winches, which are made by the builders.

A complete auxiliary outfit is provided, consisting of electric light plant, large ballast pump, sanitary pump and general steam pump for deck use, as well as bilges and boilers. The exhaust steam from all auxiliaries is led into a separate condenser, fixed in the engine room, of the "Contraflo" type, made by Richardsons, Westgarth & Company, who also constructed the evaporator and the Geddes water traps for the intermediate and low-pressure valve casings. These traps automatically drain the water from their respective casings, and lead it into the hotwell. Benjamin Taylor.

Vibration in Passenger Ships.*

Some surprise and disappointment has been expressed by passengers on turbine-propelled ships that vibration, although it has been greatly reduced, has not been entirely eliminated from these vessels. In considering this subject, it may be as well to state at once that, no matter what kind of engine be used, vibration never will be eliminated from steamships driven by screw propellers. The hull of a steamship is a highly elastic structure and, therefore, peculiarly sensitive to any forces tending to set up vibration. These forces may be broadly divided into three kinds—the impact of the waves, the unbalanced moving weights of the engines, and certain inequalities in the thrust of the propellers.

Vibrations due to the shock of the waves may be disregarded as being too infrequent to cause any discomfort. It is only in heavy weather that they become of sufficient magnitude to attract the attention of the passengers, and even then it is only at long intervals that the sea will strike a blow sufficiently powerful to cause the whole ship to vibrate.

The second cause, unbalanced or imperfectly balanced moving weights in the reciprocating engine, is, or rather was, the most annoying trouble, since it was responsible for that incessant pounding, and in some cases very violent vertical and lateral vibration, which was for many years the bane of a deep-sea passage. A few years ago, however, after a thorough investigation, Messrs. Schlick, Yarrow and Tweedy devised a system of arranging the relative positions of the cranks and other moving parts of the engine, which resulted in a great improvement; although in the latest high-powered trans-Atlantic ships a considerable amount of engine vibration still remains, especially when the engines are racing. With the introduction of the steam turbine, however, vibration from the engine was absolutely eliminated, the moving parts being perfectly balanced and, therefore, incapable of producing those mechanical couples which, in the reciprocating engine, send a rhythmical series of tremors through the whole structure of the ship.

The public at large, on hearing that an absolutely vibrationless engine had been produced, jumped to the over-hasty conclusion that all vibration of the ship had at last been eliminated. In this they were not altogether to blame; for it must be admitted that the sponsors of the steam turbine, in speaking of its future benefit to marine navigation, had predicted an absence of vibration from the whole ship, which their knowledge of propeller action should have taught them was, in the very nature of things, impossible. The writer has stood in the engine room of the *Lusitania* at a time when there was perceptible vibration in the structure of the ship at a point some 200 feet farther forward, and failed to perceive the slightest sensible vibration of the engines, even when the hand was laid upon the casing of either the high-pressure or low-pressure turbines.

For the causes of such vibration, then, as occurs in a turbine-propelled ship, one must look outside of the hull itself; and it is to be found, as we have already remarked, in the uneven action of the propellers, whose effect does not consist, as it theoretically should, in a constant axial pressure on the ship, but in a thrust which varies from a maximum to a minimum, and is in reality a series of rhythmical impulses. Theoretically, a three-bladed propeller, rotating at a certain rate of speed in undisturbed water, should exert a constant thrust.

But, in the case of steamship propulsion, the propellers, so far from revolving in undisturbed water, exert their thrust upon water that is very much disturbed, and flows past them in streams of varying velocity, full of eddies and more or less complicated motions. This movement is largely due to the friction of the water upon the sides of the ship. The layers of water in immediate contact with the hull tend to cling to it, and are dragged along with increasing velocity, until at the stern of a long ship they are traveling approximately at the same speed as the vessel. This drag on the water decreases with the distance from the hull, until undisturbed water is reached. Now, as a propeller rotates, its blades are alternately reacting upon dead water and water which is moving more or less swiftly forward against the thrust which the blades exert; and, consequently, the reaction against the blades is greater, or of a less yielding character, as they are passing through the water next the hull than when, on the other half of their rotation, they sweep through the still water 15 or 20 feet away from the hull; in other words, each blade once in every revolution hits a hard spot, as it were, in the water, with the result that the impact sets up a series of tremors or vibrations throughout the whole structure of the ship, whose frequency will be equal to the number of blades in the propeller, multiplied by its speed of rotation. Thus, in the case of the *Lusitania,* whose three-bladed propellers make at full speed about three revolutions per second, one would expect to find, if this theory be correct, a frequency of vibration of about nine per second. Observations by recording instruments show that this is exactly what occurs.

It is evident, then, from the above considerations, that although the steam turbine has entirely eliminated engine-room vibration, passengers on future high-speed boats must be prepared to submit to such limited discomfort as arises from vibrations which seem to be for the present entirely beyond human control. Evidently, if vibration is to be entirely eliminated, we must find some other means of propulsion than the propeller. There is one system which would bring about the desired result, namely, that of jet propulsion; but jet propulsion, in spite of the many ingenious efforts to develop it, has never proved a practical success, at least for high-speed vessels.

* *Scientific American.*

HOUSE BOAT SOMMERNACHTSTRAUM (SUMMER NIGHT'S DREAM), WITH ELECTRIC DRIVE.

MODERN MOTOR LAUNCHES.

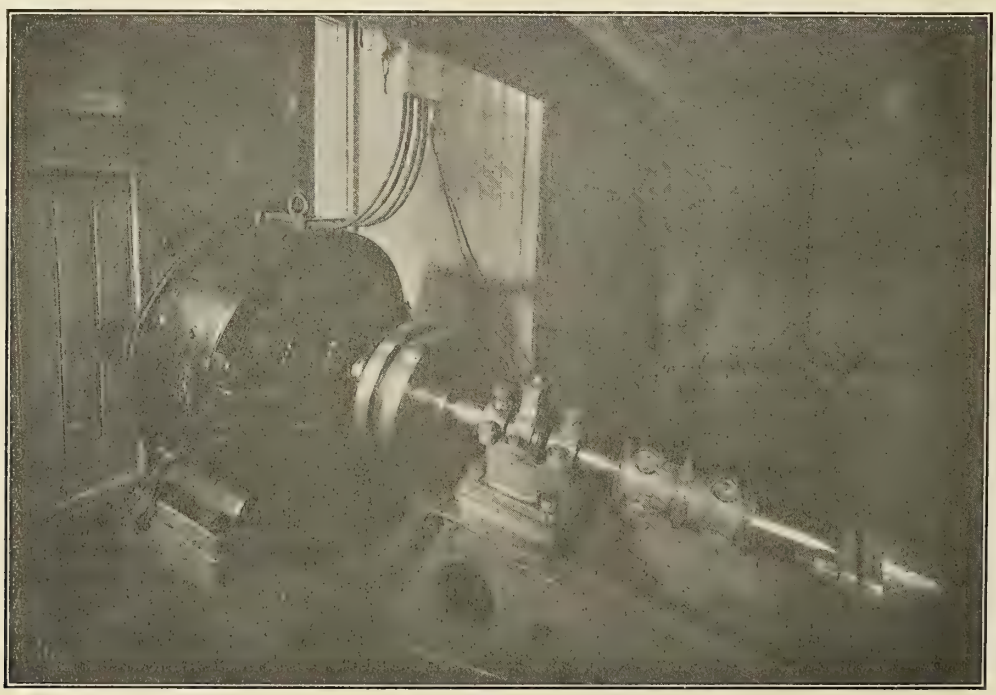
BY DR. ALFRED GRADENWITZ.

Many of the recent advances in the field of transport and locomotion are due to the extraordinary development of small-sized explosion motors. This applies both to automobilism (which has brought about something like a revolution in modern traffic) and to aeronautics, which seems to be on the eve of a powerful development.

The experience gained in connection with automobile construction has been lately made use of also for the construction of motor launches. As a suitable motor had been developed, no difficulties were experienced in the construction of light and swift motor-driven boats, the more so as such motors will be readily fitted into even the smallest crafts. Motor launches are accordingly at present used to a large extent, both for the transport of passengers and merchandise, for racing, sporting, touring and pleasure purposes, for maintaining regular connections in the short and long-distance traffic, for conveying merchandise from ship to ship, from ship to land, from the place of production to the loading place, and so on. They are even used largely by the authorities as superintending boats in the custom service, mail launches, etc., and even the navy has found it profitable to replace part of their steam pinnaces by motor boats. The low weight, simplicity of operation and readiness for service are the main causes for the rapid strides made by this type of craft, which have brought animation to many waters that had so far been outside of any traffic.

While in most cases explosion motors of the automobile motor type are used for the propulsion of the launches, electric motors fed from storage batteries are fitted not infrequently into the latter, a special advantage of electric operation being the perfect smoothness and absence of any noise, and small electric launches are accordingly especially adapted for use as pleasure and touring boats. When driven by such a motor the boat will traverse quickly the water sheet of mountain lakes, passing by the towering peaks and steep slopes, and disturbing by no creaking or oscillation the grandeur of the scenery.

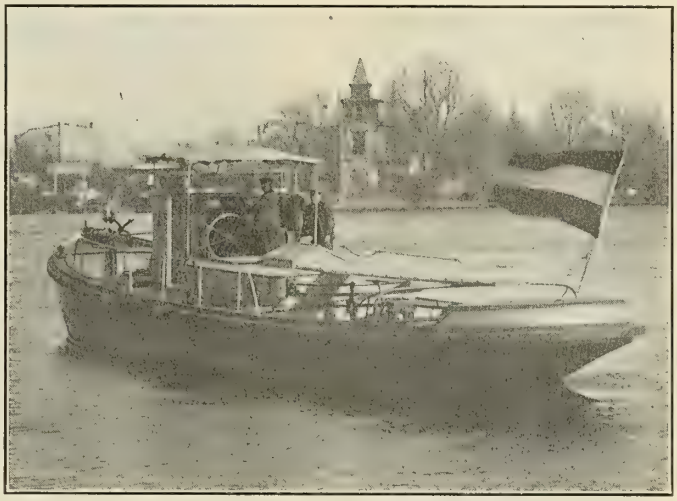
ELEVEN-METER BOAT WITH 5-HORSEPOWER ELECTRIC DRIVE.



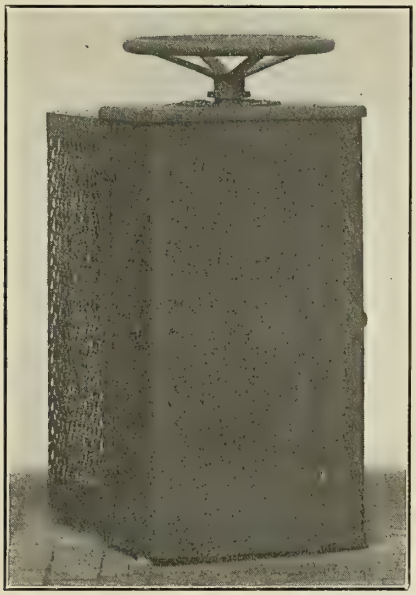
MOTOR FOR DRIVING BRICK BARGE—3 TO 7 HORSEPOWER, 100 TO 125 REVOLUTIONS, 160 VOLTS.

TRIPLE-SCREW, ELECTRICALLY DRIVEN TOWBOAT TELTOW, WITH ACCUMULATOR DRIVE, 60 HORSEPOWER.

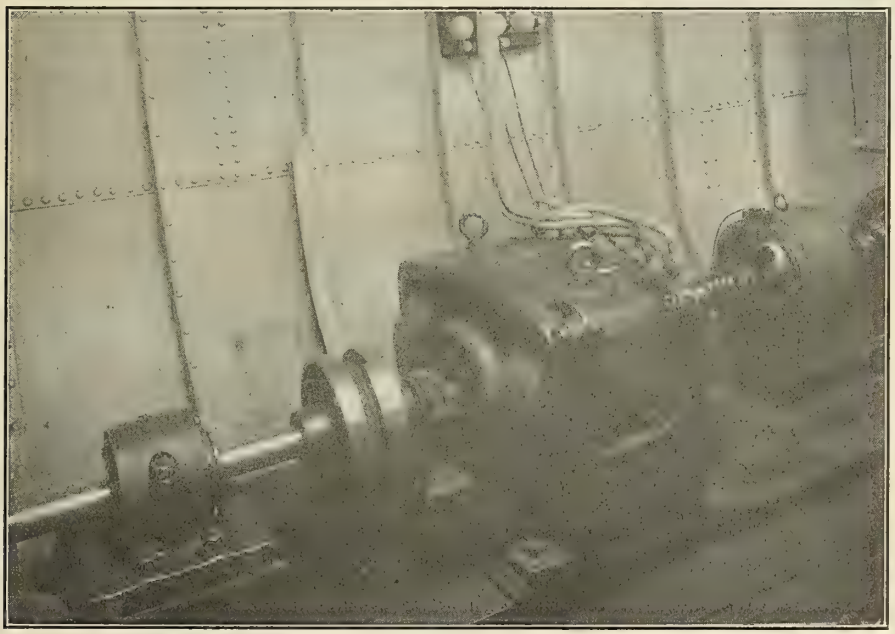
The smoothness of operation may be said to be an advantage, even from an economical point of view, the efficiency of the propeller being more advantageous than in the case of explosion motors, so as to reduce the consumption of energy in spite of the additional weight of the accumulator battery, at least in the case of moderate speeds. Electric operation may, accordingly, be preferred wherever no specially high speeds are required, such as in the case of ferries, hauling boats or goods launches.



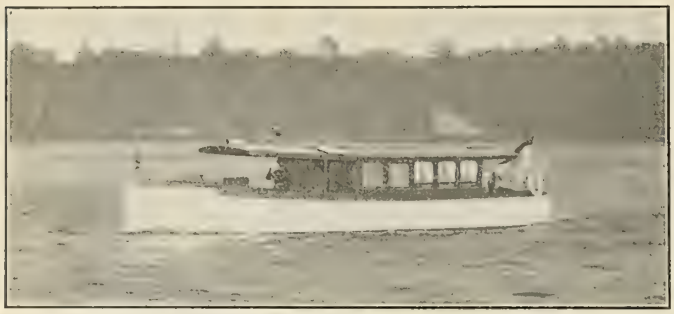
TRIPLE SCREW TOWBOAT TELTOW, SHOWING CONTROL PLATFORM.



CONTROLLER FOR ELECTRIC DRIVE.

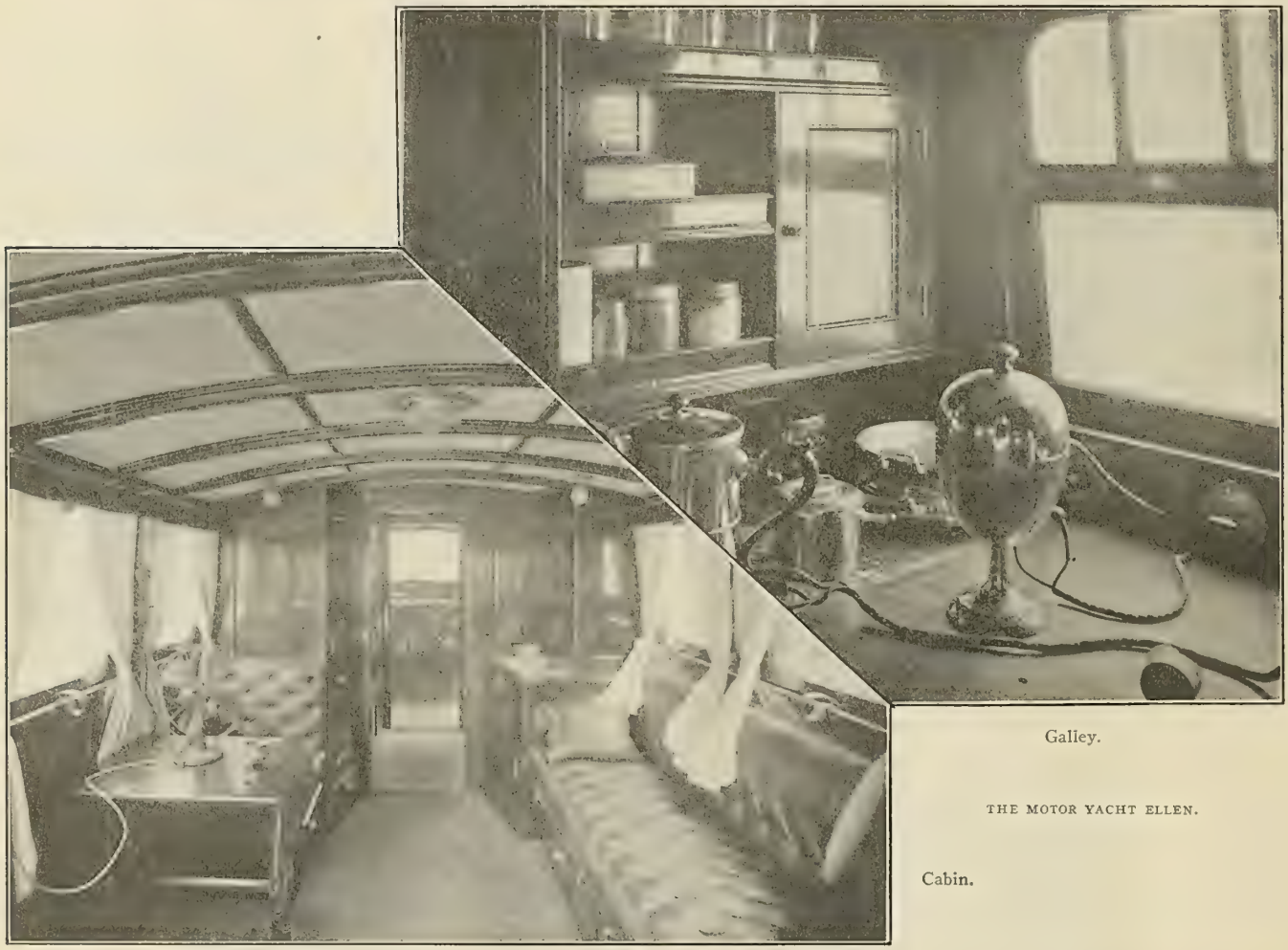


MOTOR OF 15-20 HORSEPOWER AT 500 REVOLUTIONS PER MINUTE AND 160-500 VOLTS. TOWBOAT TELTOW.



MOTOR BOAT ELLEN IN MOTION.

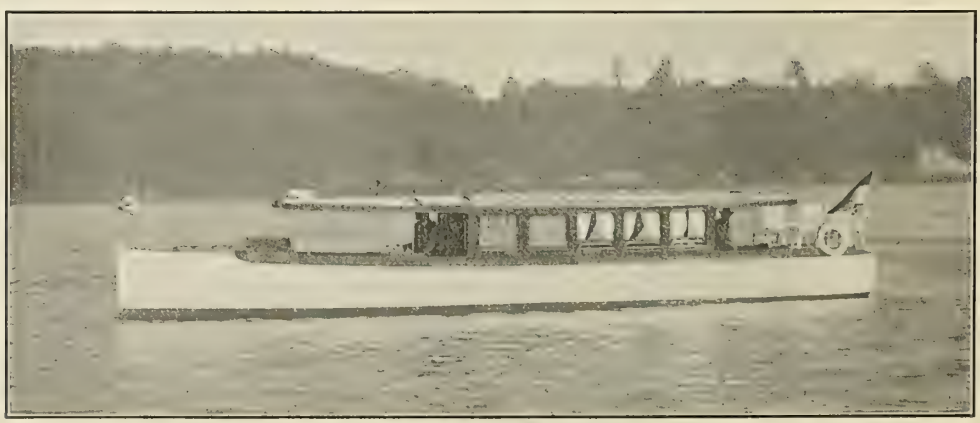
The electrical energy stored in an accumulator battery will allow of a single journey up to 100 kilometers (62 miles) in length, after which the battery, having become exhausted, must be recharged. Electric launches are accordingly bound up to charging stations, and are hardly adapted for use as long-distance traveling boats. Explosion motors, operated either by benzine, paraffin (gasoline) or any other kind of fuel, are, on the other hand, very suitable for journeys of several hundreds of kilometers, and while occupying only little space and being of small weight, will be readily replaced whenever required. However, benzine motors are far from being so simple to start and control as electric motors. Endeavors have accordingly been made from time to time to combine the



Galley.

THE MOTOR YACHT ELLEN.

Cabin.



MOTOR YACHT ELLEN, WITH BENZINE-ELECTRIC DRIVE AND ELECTRIC LIGHTING, COOKING AND SIGNALING.

BARGE OF THE BRICK TRANSPORT COMPANY, WITH 7-HORSEPOWER ELECTRIC MOTOR DRIVE.

individual advantages of each of these two systems, and a very practical mixed system has been recently evolved by the Siemens-Schuckert Works, Nonnendamm, Berlin, Germany.

This system comprises a benzine motor and a motor-driven dynamo connected by an electro-magnetic clutch, while another similar clutch connects the dynamo with the propeller shaft. In parallel to the dynamo there is connected an accumulator battery, which on starting will rotate the electric motor as soon as the controller has been actuated, while the propeller shaft at the same time is slowly rotated as soon as the benzine motor has begun working. This is mainly relied upon to yield the energy required to operate the propeller, the electric motor being mainly used to control the speed.

The limits of speed control are very wide ones, as the motor-driven dynamo, in case of reduced speeds, will exert a braking action on the benzine motor, while increasing the total output to about twice the output of the benzine motor in case of increased speeds. The braking energy, however, is by no means lost, but is stored as electrical energy in the accumulator battery. The backward running is effected exclusively by electricity, thus dispensing with any reversing gear. When permanently disconnecting the benzine motor, a purely electric operation can be resorted to, even in forward running, when all the advantages of electric operation will be fully enjoyed. According to the size of the battery and the speed of the launch, this electric service can be extended to one or more hours. The same benzine-motor dynamo set is used, after disconnecting the propeller shaft, to recharge the battery during intervals in operation. The boat thus becomes independent of any charging station, a large advantage over other electrically-operated launches.

Another good point of this mixed system is the possibility of providing, by the aid of the storage battery, for an extensive electric lighting plant, fitting electric fans for ventilating the various rooms, and operating an electric searchlight, as well as a pump for emptying the ship's hold, and an electric siren. Even the kitchen stove in the pantry and the cigar lighter in the saloon are readily adapted to electric operation, and as no matches or open fires need thus be used on such boats, the cleanliness and comfort are obviously enhanced, while the safety against fire is greatly increased.

The illustrations herewith reproduced show some of the various types of motor-driven boats at present in use, including motor boats for the passenger traffic, pleasure and touring boats, launches for use in the towing service on canals and in harbors, and motor-operated boats to be carried on board merchandise vessels. The photograph which represents a brick-transporting barge illustrates the simplicity with which an ordinary barge is adapted to motor operation. The outward appearance of the barge is altered in no respect by fitting the electric motor, while operation is made exceedingly simple, the vessel being able independently of any one of the usual means of transport (towing motors or hauling tugs) to go on its journey far more rapidly than heretofore. Some of the illustrations represent inside views of the mechanical part of a motor-driven launch designed for "mixed" operation.

Use and Abuse of Staybolts.*

The safest and most effective staying for locomotive and marine boilers is a subject of the highest importance. The frequent discussions and conflicting opinions advanced from time to time as to the best methods, etc., are evidence that there is no well settled or uniform plan adopted for this important feature of boiler construction. While it is agreed that metal of high quality and vibratory power is necessary, there seems to be no unity of thought as to the best design of stay-bolt that would come nearest to the qualities of safety, economy and endurance. The strenuous service, the prevailing necessity of rapid heating and cooling of boilers, causing extremes of temperature, the adoption of high pressures and the frequent failures of the constructive parts, often followed by serious results, should attract to the subject our deepest thought and attention.

Stay-bolts have a diversified mission. To the tensile strain, used in sustaining the fire-box sheets in normal position, are added irregular bending forces, due to expansion and contraction. The outer ends of solid stay-bolts are usually at a temperature of less than 300 degrees, while the inner ends are struggling at a temperature of between 700 and 800 degrees F. Torsional strains are also very often in evidence, due to untrue alinement of holes, and thus we obtain, from the first day in service, forces bordering on dangerous fatigue of the metal. However, premature or early breakage is often directly due to impure metal or metal not sufficiently cohesive to long endure the frequent reversal of forces. It is quite evident that to obtain reasonable endurance, iron suitable for stay-bolts must receive special attention in manufacture.

The attention of the writer was called to the use of hollow stay-bolts. The bars from which these bolts are made have a central hole formed by being rolled in the center. This practice assures solidity, increases tensile strength and high elasticity of the metal and prevents any possible defective welds, all being qualities necessary to endurance in stay-bolt service.

The great endurance shown by the hollow stay-bolts is attributed to several causes. The method of rolling, both at the center and outside of the bars, creates a substantial unity of the metal, assures freedom from improper welds, the pure and high quality of the metal, forming the base from which the bars are rolled, tends to both strength and elasticity, the very qualities required to endure continued reversal of strains longer than iron manufactured under ordinary methods.

It is well known that the strength of wrought iron decreases after reaching 350 degrees F. Moderately high fire-box temperatures cause solid stay-bolts to reach the depreciative heat, this being one of the causes which shorten their life. With the hollow stay-bolts in service, a streamlet of cool air passes through each bolt to the furnace, thus holding the metal at a lower temperature, rendering both strength and endurance that cannot be obtained with the use of the highest possible grade of iron in the solid stay-bolt. The greater endurance of the inner ends of the hollow bolts as compared to the solid is

* Abstracted from *The Boiler Maker.*

very noticeable. This is due to the in-rushing oxygen through the hole, cooling the ends of the bolts and reducing the waste of the iron, due to the high heat of the fire.

Hollow stays, with both ends open, will never stop up, as the current of air passing through them always keeps the holes free from sediment. Furthermore, the hollow bolt saves material and time in application and renewals, and also prevents injury to sheets in making renewals, as the operator has a central hole for his drill to follow. John Hickey.

A Novel Dredge Director.

One of the greatest difficulties experienced in operating hydraulic dredges, where a specific cross-section of excavation is desired, is the inability of the dredge operator to know the exact location of the cutter, as regards the outline of the desired excavation, the cutter being concealed from the operator by the non-transparency of the water. Without going into the various methods now employed to keep the cutter within bounds of the desired cross-section of excavation, a description will be of interest of a simple machine which has recently been designed,* by means of which the operator of a hydraulic dredge of the spud and swinging type can so control the movements of the dredge as to produce a cross-section of excavation of any desired shape, which will be entirely within a liberal interpretation of the specifications.

In cases where the question is one of so many feet depth of water between certain lines, as in harbor or channel work; or in the reclaiming of land, where it is a case of filling rather than that of excavating; the exact shape of the cross-section of excavation is not of so much importance. But in canal or inland waterway work, where it is especially desired to excavate to a certain standard of cross-section, the problem of so doing with hydraulic dredges becomes of considerable importance, and past experience has shown it to be a difficult problem to obtain satisfactory results with the present methods of operating such dredges. It is to meet just such a problem that the machine herein described was designed.

The machine consists of a device whereby the exact location of the cutter of a hydraulic dredge, as regards the standard outline of desired excavation, is indicated on a diagram placed in plain sight of the operator or leverman.

It consists of four essential parts:

(*a*) A differential drum located upon the "A" frame of a hydraulic dredge, at a certain determined point.

(*b*) A diagram table upon which is drawn the outline of the desired excavation, and over which runs a tracing point, movable in two directions at right angles to each other, located within plain sight of the leverman or operator.

(*c*) A vertical shaft with a quadrant secured thereto, with a horizontal sighting bar at its upper end, located at the neutral pivoting point of the dredge, on its center line. A circular platform is so located as regards the sighting bar that a man can walk back and forth over same, and, at the same time, by taking hold of a handle at the after end of said bar, rotate the vertical shaft as necessary in the swinging of the dredge on its spuds.

(*d*) Various wires, shafting or other means for properly connecting the above three parts together, so as to make them all work in unison.

The parts are designed so as to be in synchronism with each other, and to so work as to cause the tracing point to move over the diagram in exactly the same manner as the cutter moves over the cross-section of the excavation.

The differential drum *E* on the "A" frame is connected to the ladder (*A*) by means of one wire (*B*), and to the tracing point (*G*) by another wire (*F*). There are two counter weights (*H* and *I*), so arranged as to keep these two wires in constant tension. Thus any raising or lowering of the cutter or its ladder will cause the tracing point to travel across the diagram in a line parallel with the center line of the dredge, and thus afford means for the operator to know at each instant the exact location of his cutter, so far as the depth of excavation is considered.

The quadrant (*L*) aft is connected by means of the two wires (*L'*) to the tracing point, one running on each side of

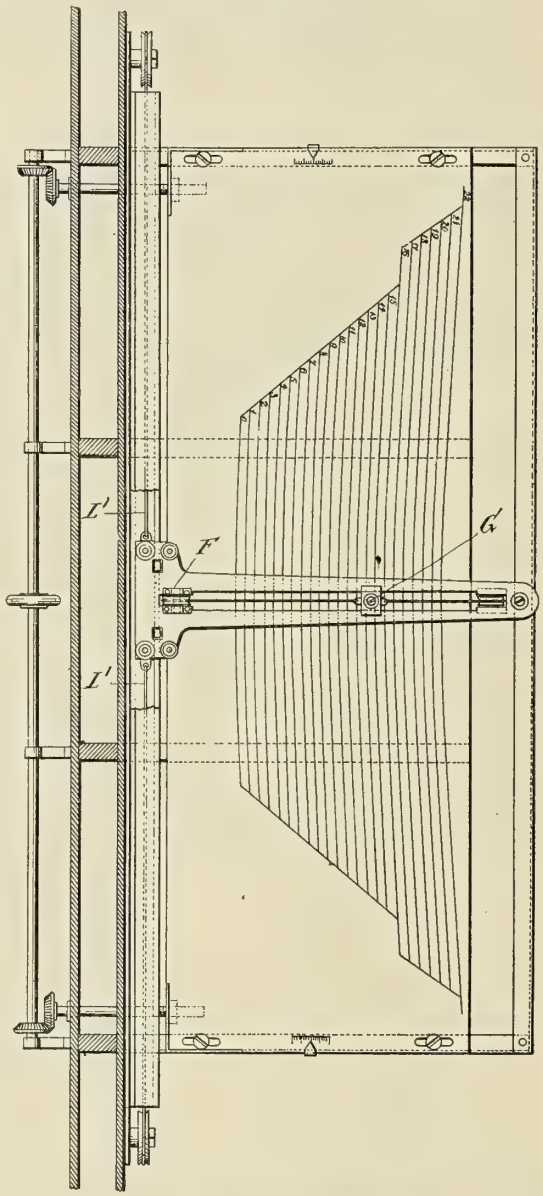


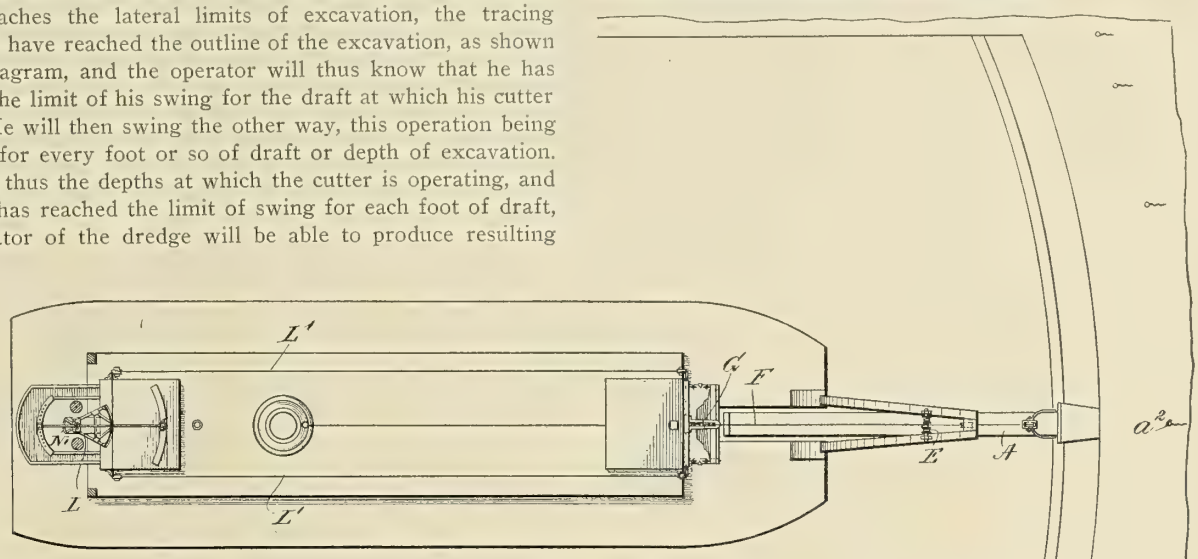
DIAGRAM OF THE OBSERVATION TABLE.

the dredge, like the tiller ropes in a small steamer. Thus any angular rotation of the vertical shaft will cause the tracing point to travel across the diagram at right angles to the center line of the dredge, and thus afford means for the operator to know the exact location of his cutter, as regards the lateral outline of excavation.

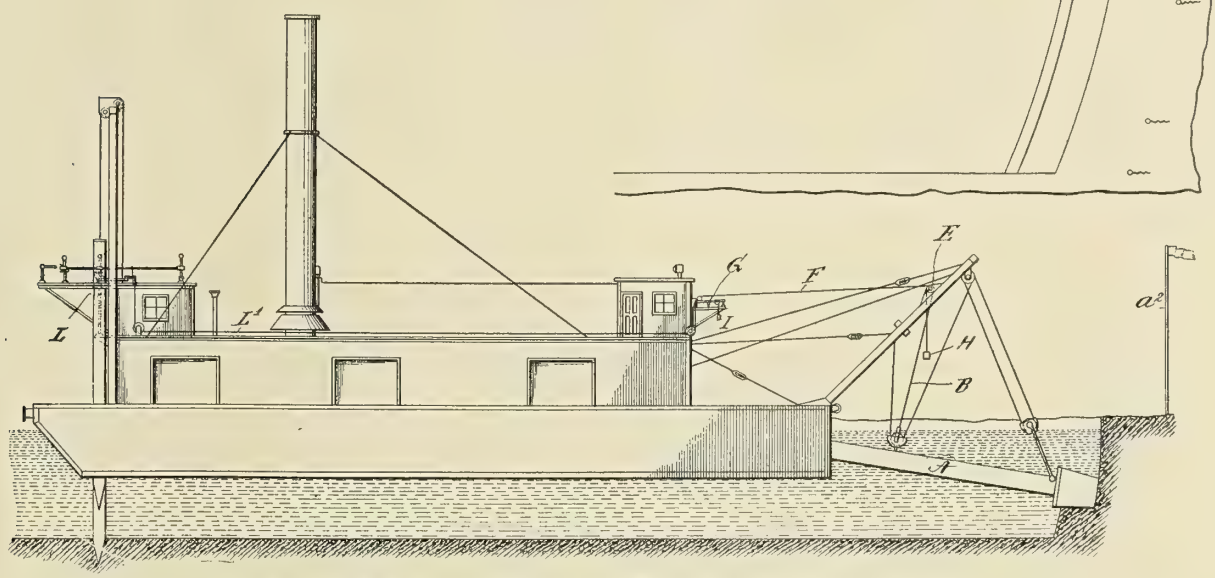
In operating this machine the one essential feature is that the man on the platform at the sighting lever aft shall always keep the sighting bar pointed towards a stake or other mark (a^2) located on the center line of excavation, some distance ahead of the dredge. This being strictly done, as the operator swings the dredge back and forth over the excavation, the quadrant will remain fixed, as far as the center line of excavation is concerned; and, the dredge swinging under it (as it

* United States patent, Feb. 18, 1908.

were), the tracing point will travel across the diagram in exactly the same way as the cutter travels across the actual cross-section of excavation. At the same instant that the cutter reaches the lateral limits of excavation, the tracing point will have reached the outline of the excavation, as shown by the diagram, and the operator will thus know that he has reached the limit of his swing for the draft at which his cutter is set. He will then swing the other way, this operation being repeated for every foot or so of draft or depth of excavation. Knowing thus the depths at which the cutter is operating, and when he has reached the limit of swing for each foot of draft, the operator of the dredge will be able to produce resulting cross-sections of excavation well within a liberal interpretation of the specifications.



PLAN OF DREDGE WITH DIRECTOR FITTED.



PROFILE OF DREDGE FITTED WITH DIRECTOR FOR LOCATING EXACT CONTOUR OF CUT.

Full provisions are made for taking up any slack in the wires, due to changes in temperature or other causes, as well as taking care of any changes of trim in the dredge, or any change in depth of water, due to a rise or fall of the tide, or other causes. By means of an electrical attachment, a bell is caused to ring in the pilot house when the dredge has reached the limits of its swing for each foot of draft at which the cutter is set.

While the above is the simplest form in which it is proposed to install such a machine, it will be possible to have the lateral movement of the tracing point controlled by means of a gyroscope located near the forward part of the dredge, by means of which the inability of seeing the range marks in foggy weather may be overcome.

The curvature of the waterlines on the table takes account of the sensible curvature obtained by swinging the line *F* from one bank of the excavation to the other without altering the depth of the cutter head. In this case this wire would swing about a center at *E* and trace waterlines as shown. Various auxiliary devices for securing the greatest possible accuracy of operation are incorporated in the design.

Shipping of the United Kingdom.

Lloyd's Register reports a total addition to the register of the United Kingdom during 1907 of 918 steam vessels aggregating 1,249,515 gross tons, this being the largest figure, with the exception of 1906, for any year under review. There were removed from the register of the United Kingdom as lost, broken up or sold 425 steam vessels aggregating 531,812 gross tons. This leaves a net addition of 493 vessels of 717,703 tons, this latter figure being the largest for any year except 1902 and 1906. On the last of the year there were 11,400 steamers aggregating 16,501,427 gross tons on the register of the United Kingdom. It will be noted that the average addition was of 1,360 tons, while the average deduction was of 1,251 tons, this indicating a slight increase in the average size of ships on the register.

During the same year there were added to the sailing tonnage of the United Kingdom 287 vessels of 28,599 gross tons, this latter figure being the lowest in ten years with the exception of 1905 and 1906. Deductions from the sail tonnage accounted

for 484 vessels and 128,432 tons, this figure being the lowest in ten years except for 1902, 1903 and 1904. The net balance was a deduction of 197 vessels and of 99,833 tons. The sailing tonnage at the end of the year was represented by 9,660 vessels and 1,575,379 gross tons. This makes the total merchant marine of Britain 21,060 vessels and 18,076,806 gross tons.

During the ten years from 1888 to 1907, inclusive, every year saw a net addition to both the number and the tonnage of steamers; every year saw a net deduction from both the number and the tonnage of sailing vessels; every year saw a net addition to the total tonnage of all vessels; every year, except the first three, showed a net addition to the total number of vessels. It may be remarked that in the ten years under review the net additions of steamers amounted to 2,828 vessels, and 6,077,584 tons; the net deductions of sailing vessels amounted to 2,231 vessels and 1,179,944 tons, while the total net additions amounted to 597 vessels and 4,897,640 tons. This indicates that at the end of 1897 there were included in the merchant marine of the British Isles 8,372 steam vessels and 10,423,843 gross tons, and 11,891 sailing vessels and 2,755,323 gross tons. This makes a total of 20,263 vessels and 13,179,166 tons.

The present figures show a very marked increase, the number of steamers having been augmented by 33.8 percent; of sailing vessels decreased by 18.8 percent, and the total increased by 2.95 percent. The steam tonnage has been increased by 58.3 percent, the sailing tonnage decreased by 42.8 percent, and the total tonnage increased by 37.2 percent. The average size of steam vessels at the end of 1897 was 1,243 tons; in 1907 it was 1,448 tons. The average size of sailing vessels at the end of 1897 was 232 tons; at the end of 1907 it was 163 tons. The average size of all the ships in 1897 was 650 tons; in 1907 it was 859 tons.

Speed in Battleship Construction.*

BY LIEUTENANT A. C. DEWAR, R. N.

For tactical purposes a 3-knot superiority is useful; for strategical purposes, 2 to 3 knots. The question will be examined from a constructional point of view. Speed may be obtained by increasing the horsepower, by decreasing the resistance (as in improved lines), or by increasing the percentage of effective horsepower (*e. g.*, by improved propeller design).

The horsepower required varies approximately as the cube of the speed. At a certain point the curve of horsepower and speed begins to steepen abnormally, and it is uneconomical to supply horsepower beyond this point. The critical speed for a battleship of the *King Edward VII.* type, beyond which the resistance begins to increase rapidly, is about 17½ knots. Thus the last knot in the *New Zealand* absorbs 20 percent of the total horsepower, and as machinery weight and space vary more or less directly as the horsepower, an increase of 20 percent horsepower means a one-fifth increase in boiler-room length, with increased weight of hull and armored belt. Beyond the point at which the horsepower curve begins to steepen rapidly, the increments of power required for additional speed are so great as to practically break up a vessel's design. Thus in the *Lord Nelson* the curve steepens at 18 knots, and an additional knot would require a total of 24,500 horsepower, or an increase of 45 percent, while the space required would be impracticable on present dimensions; for 20 knots the horsepower required would be 37,000, or an increase of over 100 percent.

If a ship is built with good lines, it requires less horsepower to obtain its speed, and to attain this, model vessels exactly shaped to a variety of lines by an ingenious tool are run in an experimental tank; the power required is very delicately measured, and the lines which offer least resistance selected. There is also a certain favorable draft to obtain the utmost speed. For a 16,000-ton ship the most favorable draft is 27.1 feet for 19 knots, and 26.5 feet for 18 knots. An increase in speed can also be sometimes obtained by utilizing non-effective horsepower; at present only about 45 percent of indicated horsepower is actually effective, 15 to 25 percent being lost between the propeller and the water. A change in the propeller blades of the *Drake* and *County* classes resulted in an increase of ¾ knot in speed.

Increased indicated horsepower can also be obtained by higher pressure or increase of revolutions; thus, in the *Triumph* and *Swiftsure,* a large saving of weight and higher speed is obtained by designing the engines for an increased rate of revolutions. The revolutions are 157 against the *Duncan's* 124, giving 14.1 horsepower per ton of machinery against the *Duncan's* 11, and 20 knots against the Duncan's 19, at the expense of greater wear and tear, and possibly a greater likelihood to breakdown.

Improved boilers also give higher pressure and horsepower for less weight. Thus the *Hyacinth,* a cruiser of the same type as the *Juno* (which had cylindrical boilers), gained 2 knots in speed and saved sufficient weight to replace the *Juno's* 4.7-inch guns by 6-inch by the use of watertube boilers. In the *King Edward VII.,* on the contrary, the adoption of a combined boiler system (fourteen Babcock & Wilcox and six cylindrical) involved an increase of 150 tons in weight, and the lower pressure required larger cylinders and more space.

The weight required to obtain the last knot in various designs varies in different vessels. The *Drake's* last knot cost 500 tons in weight, corresponding to about 2,000 in displacement. The *Renan* obtained 1 knot extra with an increase of 1,100 tons and the removal of four 16.4cm. (6.4-inch) guns. In the *Idaho* class 1 knot extra for a 17-knot battleship involved an increase of machinery weight of 570 tons, which, with increased length of hull and armored belt, would mean an increased displacement of about 2,500 tons. The *Good Hope* required 700 tons to get her last knot; and in the *République* an increase of 1 knot would mean an increase in displacement of 1,000 tons.

An analysis of the extra displacement required to increase the speed from 18 to 19 knots in the *Charles Martel* (11,700 tons, 14,500 horsepower) is as follows:

	Tons.
Increase in machinery weight	230
Increase in hull weight	310
Increase in armor weight	380
Increase in coal weight	80
	1,000

—an increase of 230 tons in machinery, necessitating an increase of 1,000 tons, or 4.4 times its own weight, in displacement.

Up to the introduction of turbines in the *Dreadnought,* the speed of battleships has varied between 17½ and 19 knots. The normal, or what may be termed the representative, speed with reciprocating engines has oscillated ½ knot on each side of 18. The *King Edward VII.* obtained ½ knot lower speed and four additional 9.2-inch guns with an increased displacement of 2,350 tons. The *Lord Nelson* obtained ten 9.2-inch instead of twelve 6-inch guns, and an additional 1 inch on her belt, by a decrease of ½ knot and an increased displacement of 2,500 tons. The trend, then, has been towards an increase of armament rather than an increase of speed. The *Duncan's* 19 knots was obtained only at a very considerable sacrifice of protection. Similarly in German and French types, speed has

* The United Service Magazine.

remained practically stationary at 18 knots, and armament has gradually increased. In American ships speed has varied from 17 to 19 knots, while very heavy armaments have been mounted. Thus the *Connecticut,* with 18 knots, carries four 12-inch, eight 8-inch, and twelve 7-inch, against the *King Edward VII.* (18½ knots) four 12-inch, four 9.2 and ten 6-inch, by saving in—

	Tons.
Machinery	600
Armor	285
Coal	80
Hull	200

The *Connecticut,* with less speed and less machinery, can afford to be shorter by 25 feet, and so saves considerably in hull weight and armor. Speed, then, in the last decade has remained practically stationary, and the reason has already been given—with reciprocating engines and average displacement, any increase beyond the representative speed of 18 knots called for excessive sacrifices. To give the *Lord Nelson* a speed of 21 knots would have necessitated an increase of about 1,100 tons in machinery, which would mean a displacement of nearly 20,000 tons, or an increase of 3,000 tons.

The introduction of the turbine, however, broke down these limitations. A speed increase of 3 knots, better armament, protection, and radius of action were possible with an increase in displacement of 1,500 tons and an additional cost of £300,000 ($1,460,000). It is important then to distinguish the position of the turbine in the present controversy over speed. The original line of increased armament has been followed, combined with an increase of speed rendered possible by the use of turbines.

The introduction of the turbine has caused a sudden rise in speed compared with the older type of battleship; but, when its use becomes general, speed will probably again reach an economical limit, oscillating a knot or so on either side, and strategical and tactical requirements will again have to subordinate themselves to constructional limitations. To increase displacement by 3,000 tons and cost by about £300,000 simply to obtain 3 knots more speed would be inadvisable, but it is a sound policy to increase the displacement by 1,500 tons, if by so doing a decided improvement is gained, not only in speed but in protection, radius of action and armament.

Criticisms on the *Dreadnought* armament* must not be confused with the speed question. The only factor to be considered relative to speed is the percentage of the total displacement allotted to armament; the nature of the armament does not affect the question. In the *Braunschweig,* armament amounts to 11.3 percent of the displacement; in the *République,* 11.3; in the *Formidable,* 10.9; in the *Lord Nelson,* 19; in the *King Edward VII.,* 14.5; and in the *Dreadnought,* about 14.8 percent. It is clear, then, that armament has not been sacrificed to speed. Greater armament and greater displacement has been the trend of battleship evolution, and the *Dreadnought* does not depart from this principle, but in her case the representative speed has been increased to 21 knots by the use of turbines.

Turbines and oil fuel also mean a smaller engine-room staff and an easier maintenance of speed, though the expense of the latter is a drawback, being 0.45d. (0.91 cent) per indicated horsepower against 0.18d. (0.36 cent) for coal. Oil, too, has a very important bearing on radius of action, for not only is its calorific value greater than coal for equal quantities, but a greater quantity can be stowed in the same space. If 2,000 tons of coal will drive a ship 2,000 miles (approximately), 2,000 tons of oil, having greater fuel energy in the proportion of five to four, would suffice for 2,500 miles; but the stowage space required for 2,000 tons of coal would stow 2,300 tons of oil, which would suffice for 2,840 miles, or a radius of action increased 42 percent by the use of oil.

Oil fuel can also be supplied much more easily and regularly to the boilers, and so speed can be better and more economically maintained. In the race of the first cruiser squadron from New York to Gibraltar, the speed dropped from 21 knots to 18 knots immediately the reserve bunkers began to be used, which might have an important strategical bearing, and which is avoided by the use of oil. Fueling at sea, too, would be much easier and safer, as no glaring lights would be necessary, and the ship could be ready for action in a quarter of an hour. This is impossible when coaling with Temperley's, and the old-fashioned coaling will always remain a risky operation within 150 miles of an energetic enemy's coast. The smoke difficulty with oil is now almost entirely overcome; the Dürr system with Texas oil produces less smoke than Welsh coal.

Watertube boilers have also a strategical value, as steam can be raised very rapidly. A ship steaming at 10 knots with four boilers alight could increase to full speed with twenty boilers in 1½ hours. To achieve the same result with cylindrical boilers, all boilers would have to be kept banked, which would mean an extra coal consumption of 60 to 80 tons per diem in a battleship. These advantages are less heard of, but are none the less very material, and they are combined in our later types of ships. With regard to cost, the figures per ton for a modern ship are approximately—

	First Cost	Upkeep Per Annum.	Annual Repair.	Triennial Refit.
Cost per ton.....	£95	£5.4	£1	£4
	$462	$26.25	$5.00	$19.50

One knot in speed may be taken as representing 1,000 tons displacement, and therefore involves an additional first cost of about £95,000 ($462,000) and an annual charge of £7,700 ($37,500). Three knots of speed, then, would mean an increased first cost of about £285,000 ($1,385,000) with an annual charge of £23,000 ($112,000). If the faster ship costs 1.8 millions ($8,750,000), the slower would cost 1.5 millions ($7,300,000), and six slow ships would correspond financially to five fast. Assuming that the armament of slow and fast is equal, the fleet fire volume of six slow would be 20 percent greater than of five fast, but this would perhaps just compensate for the inferior speed. Financially and tactically the two fleets would be on a par, but in forcing or evading action, the faster fleet would, of course, have a great advantage, not the least being the ability of its units to go to and fro unescorted.

As a matter of fact, in the *Dreadnought,* 3 knots greater speed is combined with a slightly heavier armament. If the rate of fire per minute at *long range* be taken as two for a 12-inch and three for a 9.2-inch, the *Lord Nelson* throws a broadside of 12,400 pounds per minute, against the *Dreadnought* 13,600; six *Lord Nelsons* would cost the same as five *Dreadnoughts* and would have a fire volume superiority of only 8.5 percent, which would not counterbalance three knots speed inferiority. Financially, then, a fleet of *Dreadnoughts* compares favorably with one of *Lord Nelsons,* and though the financial risk from submarines and mines is greater, the larger ship is also less easily disabled.

Any comparison of features complementary to one another is so dependent on circumstances, that no dogmatic conclusion can be arrived at. The relative value of the heart and lungs, of man and woman, of intelligence and physique, cannot be defined in figures. One factor, however, is usually dominant, and the great majority of captains, if asked to choose between 2 knots in speed and two 12-inch guns, would choose the guns. Armament is the first consideration in a battleship, and if it is essential to bring the enemy's fleet to action, for every eight

* Some artillerists prefer the *Lord Nelson's* armament—a combination of 12-inch and 9.2-inch; the retention of the 6-inch is advocated by others.

battleships built, a fleet of three battle cruisers should be provided. A difficulty in the way of providing heavier armament is the enormous length of our guns, which really require as great a hull length (and therefore additional hull and armor weight) as speed. The matter might be greatly simplified by using a shorter and stronger gun with heavier charge, but that again would require heavier and stronger mountings.

In any case, arguments against large battleships cannot be based on historical records. Railway managers do not base their traffic sheets on coaching records, and there is as much difference between a modern battleship and a sailing vessel as between a locomotive and a stage coach. Yet a competent naval writer has actually based an argument against the *Dreadnought* on the number of seventy, eighty and one-hundred-gun ships in the post-Napoleonic period. This is a good instance of a fallacious study of history. The large sailing ship was unpopular because it was slow, clumsy, and sagged to leeward; the large modern ship is faster than the small and just as handy; the large sailing ship was superior only in number, not in size of guns, which had no greater range than those of a seventy-four. The large modern ship carries heavier metal with greater range, and its size is a consequence as much of its speed and protection (a factor entirely absent from wooden construction) as of its gunpower.

The real arguments against large ships are the necessity of large docks, greater cost, and increased loss in event of accident, but these arguments have not prevented a gradual increase in the size of all battleships.

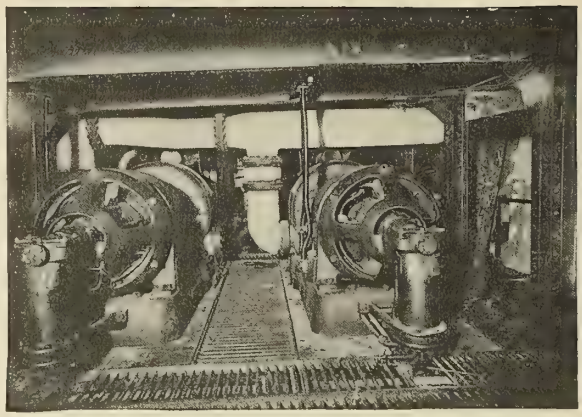
The whole problem can be summed up in a few words—armament is essential and speed is necessary, and the only solution is increased displacement. The question is continually asked, "What limit is there to the size of these mammoths?" The same question may be asked of Atlantic liners (which are nearly twice the size of our largest battleships) or sky-scraping hotels—no precise limit can be laid down. It depends on the progress of mechanical science and international competition, on the one hand, and financial policy on the other. The *Dreadnought* type gives distinct advantages, which, of course, have to be paid for.

Electrical Equipment of the Steamship Momus.

It is a well-known fact that on board ship, where every inch of space counts, all generating apparatus, whatever its nature, must above all possess the feature of compactness. To no other part of the generating apparatus does this apply with more force than to the generating sets for electric light and power. The space usually reserved for the electrical apparatus is always comparatively small, and at times totally inadequate for the proper handling of the apparatus. It is, therefore, not surprising that marine engineers are always eager to adopt any type of generating set that embodies compactness, with the ability to give reliable and satisfactory operation with minimum attention. A noteworthy example of a modern marine generating plant is found on board the steamship *Momus*, built for the Southern Pacific Company, of New York, by William Cramp & Sons, of Philadelphia.

The generating units consist of two 75-kilowatt, 110-volt direct-current generators, direct connected by means of flexible couplings to Curtis steam turbines of the horizontal type, revolving at a speed of 2,400 revolutions per minute. Each turbine is of the two-stage condensing type, each stage having two bucket wheels and one set of intermediate or fixed buckets. The turbines and generators are each equipped with two bearings, and each set is assembled on a rigid bed-plate cast in one piece.

The generators are of the four-pole compound-wound type, and of the latest and most improved General Electric design.



TWO CURTIS-GENERAL ELECTRIC TURBO-GENERATORS.

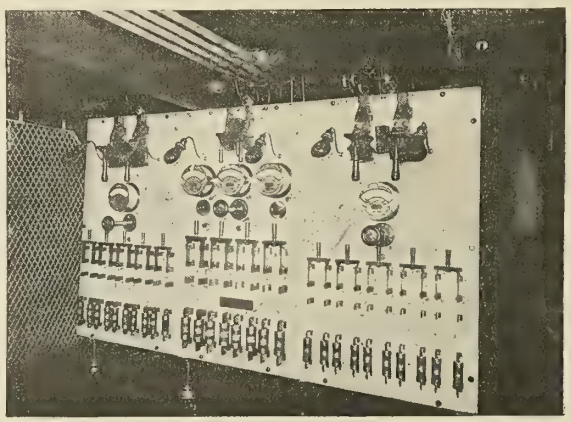
On account of the high speed, the commutators are of the shrink ring construction, the segments being held firmly in place by steel rings shrunk on the commutator and insulated therefrom by mica bands of suitable thickness. Specially treated carbon brushes eliminate commutator troubles and reduce brush friction to a minimum.

With 250 pounds steam pressure, 28 inches of vacuum and 100 degrees F. superheat, the steam consumption per hour at full load is 24.5 pounds per kilowatt, delivered at the generator terminals, assuming the generator efficiency at 90 percent. This figure is equivalent to about 16.5 pounds per brake-horsepower under the conditions given.

The high speed of operation makes the question of lubrication a very interesting one. All working parts of the valve gear, including the oil reservoir on the hollow governor lever, are oiled by hand. The main bearings are furnished with oil under pressure from an oil pump on the end of the generator shaft. All four pillow blocks are provided with auxiliary oil wells and rings. The bearings are of the self-alining, ball-seated, babbitt-lined type, made in halves. Notwithstanding the high speed, no vibration is noticeable when these sets are running under full load.

A 10-kilowatt generating set, consisting of a General Electric marine-type 110-volt generator, direct connected to a single cylinder engine of the same make, furnishes power for the ordinary day load of the vessel when at sea, and is also used when the vessel is discharging cargo at the docks.

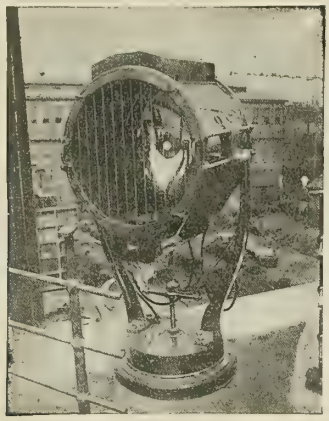
The switchboard is constructed of white marble, and consists of three panels; the outside panels being for the 75-kilowatt sets, while the inside panel is for the 10-kilowatt set. The switchboard is equipped with the necessary instruments, and the connections are so arranged that the 75-kilowatt sets



THE MAIN DISTRIBUTING SWITCHBOARD.

may be run in parallel, and any circuit may be connected to any set.

This vessel is equipped with a 24-inch General Electric searchlight, with pilothouse control. The light is installed on top of the pilothouse, and projects a beam of light of sufficient intensity to render plainly discernible, on a clear, dark



THE SEARCHLIGHT.

night, a light colored object 10 by 20 feet in size, at a distance of not less than 5,000 yards. This lamp is of the horizontal carbon type, and is designed for both hand and automatic feed.

Besides furnishing power for light, the generating sets supply current for the electric heating system, ventilating fans and numerous small motors driving dish-washing machines, ice cream freezers, etc. The electric heaters, of which there are 175, were designed especially for this installation by the General Electric Company. The use of electric heaters was a rather bold and unprecedented departure from the regular practice of steam heating, but up to the present time the operation has been entirely satisfactory.

A New Method for the Purification of Water.*

With the advancing development of the industrial arts, competition also becomes continually sharper, so that the manufacturer is compelled—as much as circumstances permit—to take advantage of the tireless progress of the technical arts. It is not long since one contented himself, fatalistically, with ignoring all the disadvantages which bad feed-water caused in the operation of the steam boiler, or hard and muddy water brought about in manufacturing operations.

Twenty-five years ago there were few manufactories which softened and cleared the feed-water for the steam boiler. When this was done, it was effected principally through large receptacles, which were filled with the water to be treated, and into which were introduced soda and lime-milk or caustic soda, or soda alone, together with a considerable pre-warming. The mixture was stirred, and, for the sake of the chemical reaction and clearing, left standing for a considerable time, and then the softened and cleared water drawn off. Other so-called anti-scale means, operating chemically or mechanically, and which were directly introduced into the boilers, have already had their true values proved and their analysis published.

Up to the present time, carbonate of soda, caustic lime and caustic soda have shown themselves the best suited, and the cheapest means for the transformation of the dissolved scale-forming lime and magnesium salts; and these have come almost exclusively into use. Since the introduction of continuously and automatically operating apparatus, the practice has passed from the primitive purification in large receptacles, which requires great attention and a great deal of room besides being expensive, so that now only the former method is in use. The knowledge among possessors of boilers that a rational method for the purification of water is of very great advantage has induced many firms to build water purifiers.

Now, although pretty much every one of these firms has been more or less successful in providing its especial equipment with new and, for the most part, patented devices, which, in comparison with the apparatus of other works, are said to have brought about a better mixing and a more economical consumption of the chemicals, or a rapid removal of the precipitated sludge, nevertheless it can not be maintained that one or another of the systems has succeeded, on the basis of these novelties, in driving the remainder off the market, or in making itself the only ruling system. The reason for this is that, on the one hand, with every apparatus, even of the older process, a sufficiently good and cheap purification may be secured, in so far as that apparatus conforms merely to the general conditions of construction relating to the art of water purification; while, on the other hand, certain evil effects, called forth by the purification and growing out of the chemical occurrences, are not removed even through the later devices.

With the process, hitherto customary, in the use of calcined and caustic soda separately, or in combination with each other or with caustic lime, the salts remaining pass into the boilers. In order that these may not reach too strong a degree of concentration, the boiler water must be, now and again, drawn off and replaced by fresh water. The exudations of sulphate of soda at the fittings and rivet holes are an unpleasant incident, which, up to the present, has had to be reckoned with. A real advance in the province of the art of water purification is, therefore, scarcely to be expected, so long as one limits himself to altering the apparatus in form of construction, or even to improving it, but retains in other respects the former procedure.

Among those who are concerned with this department, a new process of water purification by means of carbonate of baryta, by virtue of which the above-mentioned evils are avoided, has, therefore, awakened considerable attention. This rests upon the fact that the finely pulverized carbonate of baryta transposes itself very energetically with the sulphate of lime contained in the water, and in such manner that sulphate of baryta and carbonate of lime are formed, both of which are insoluble in water and, on that account, are precipitated as sludge. Thus the very important phenomenon comes to light—that not only the sulphate of lime, which was dissolved in the water before its purification, and which appears in the boiler as a scale former, is precipitated, but also the chemicals occasioning its precipitation. For this purpose it is requisite that a corresponding and sufficiently large mass of carbonate of baryta be present, through which the water to be purified is passed. To accomplish this it is added in pulverized form, and in considerable excess—in most cases sufficient for several months—and thus without mixing.

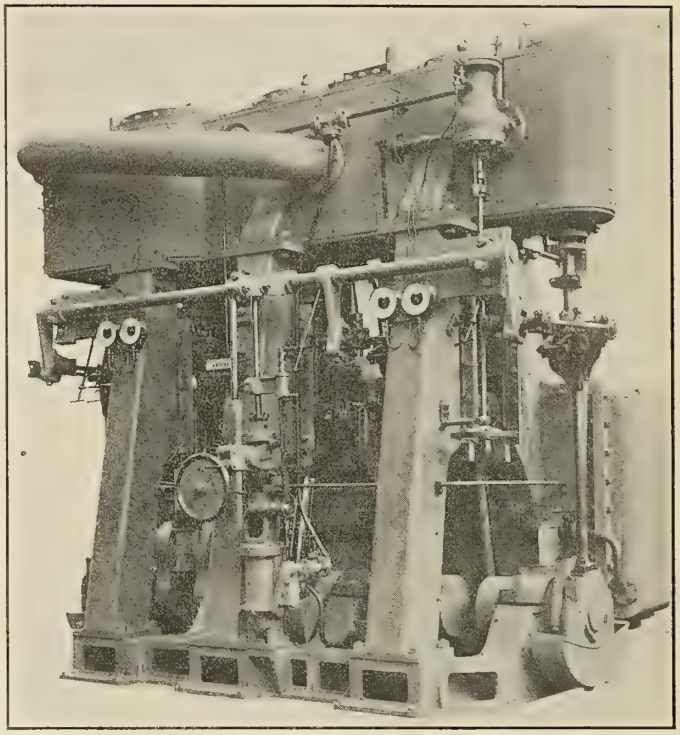
This is carried on in the receptacle for reactions and clarification belonging to the apparatus constructed for this process. In the lower conical part of this the water to be purified enters by fits and starts. By this means is brought about a continually renewed whirling up of the baryta, and the sulphuric acid contained in the water is completely bound by it. In the upper part of the purifier the water passes through a filter, in which all the sludge particles which may have been carried along are retained. These are, from time to time, washed back into the bath of baryta—for one thing to avoid the loss of baryta and for another to cleanse the filter. In order to free the water from carbonates, caustic soda is employed, which is dissolved

* Translated from *Maschinen- und Metallindustrie-Zeitung.*

in a continuously-operating Dervaux lime saturator, and led to the reaction receptacle.

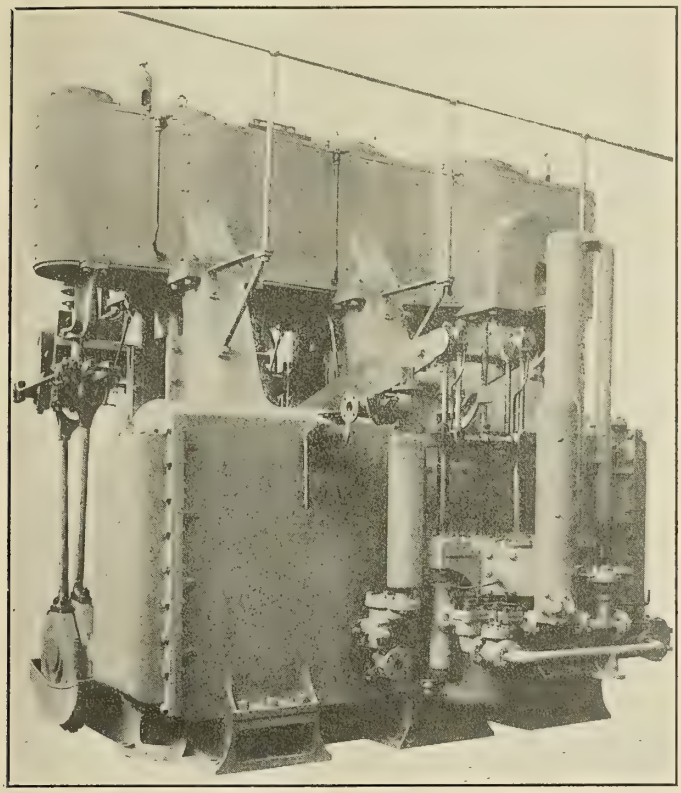
In connection with the devices already carried out, and which have been in operation for two years, for this kind of water, it has become manifest that a renewal of the carbonate of baryta, according to the hardness of the water, is necessary only every one to four weeks. The drawing off of the sludge, on the contrary, need be carried out at most only every three months. The current expense is frequently less—but usually not higher, or but slightly higher—than with the soda-lime process. But if one takes into consideration the advantages of the new process, then this slight increase in cost vanishes. For since, with the tranformation of the sulphates, none remains in solution, even the troublesome exudation of sulphate of soda ceases, which (if allowed to continue) causes not merely the ruin of the fittings but also other evils—as, for instance, increase of the specific gravity of the boiler water, and increase of the boiling point, resulting in a reduction of a saving of fuel. Extremely hard water cannot be softened through treatment by means of carbonate of soda, apart from excess of the same, and very considerable prewarming, to the extent that it passes on without an after-reaction in the boiler as well as on the way to it. And so deposits are made in the piping, prewarmer and injector. These cannot arise with the purification by means of baryta any more than can foaming of the boiler water, which, especially in locomotives, is so important on account of the so-called "spitting."

In the case of the presence of corroding substances in the water—for instance, chloride of magnesium, which is not present in all waters and, for the most part, only in exceedingly small quantities, and upon which baryta exercises no influence—a breaking up of the chloride of magnesium into magnesium hydrate and common salt is brought about by the addition of suitable chemicals. It is thereby made completely harmless, so that no corrosion can arise. It may be added that carbonate of baryta cannot be applied in the place of the carbonate of soda without further ado, but that there is needed for this purpose an especial arrangement in the apparatus for the purification of the water. But water purifiers of almost every sort can easily be modified for this purpose. The new process is patented.



STARTING SIDE OF ONE OF THE TRIPLE-EXPANSION ENGINES OF CUBATAO.

THE TWIN-SCREW STEAMER CUBATAO ON TRIAL TRIP.



BACK SIDE OF TRIPLE-EXPANSION ENGINE OF CUBATAO.

The Steamship Cubatao.

On Oct. 21, 1907, Craig, Taylor & Co., Ltd., launched from their yard, at Thornaby-on-Tees, a handsomely modeled twin-screw steamer of the following dimensions: Length, 286 feet; beam, 44 feet 9 inches; depth, 17 feet 6 inches. She is designed to suit the special trade of the *Lloyd Brazileiro,* and is of the single deck type, with deckhouses amidships and forecastle forward. She was built under special survey to class with the British Corporation. The vessel has double bottom for water ballast in the holds, and has also water ballast in the peaks.

The machinery was constructed by Blair & Co., Ltd., Stockton-on-Tees, and consists of two triple expansion engines, with cylinders 14, 22 and 37 inches in diameter and a piston stroke of 24 inches. These are supplied with steam by two large steel boilers working at 185 pounds pressure per square inch. The vessel has Vicker's stern tube appliances.

She is fitted with vertical steam windlass with quick warping ends by Clarke, Chapman & Co.; Hastie's Wilson-Pirrie steam steering gear, placed in house aft, and worked from bridge amidships by telemotor; eight steam winches; double derricks for rapid loading and discharging, with gins and blocks having Reid's patent sheaves; Clayton fire and disinfecting machinery; electric light by Siemens Brothers, and all modern improvements for a first class cargo steamer for the Brazilian trade, including Waile's-Dove's bitumastic enamel to the tanks, Christie's sparring cleats, litosilo to cabins, Hoskin's beds, and lifeboats with Mills' disengaging gear.

A New Transfer Towboat.

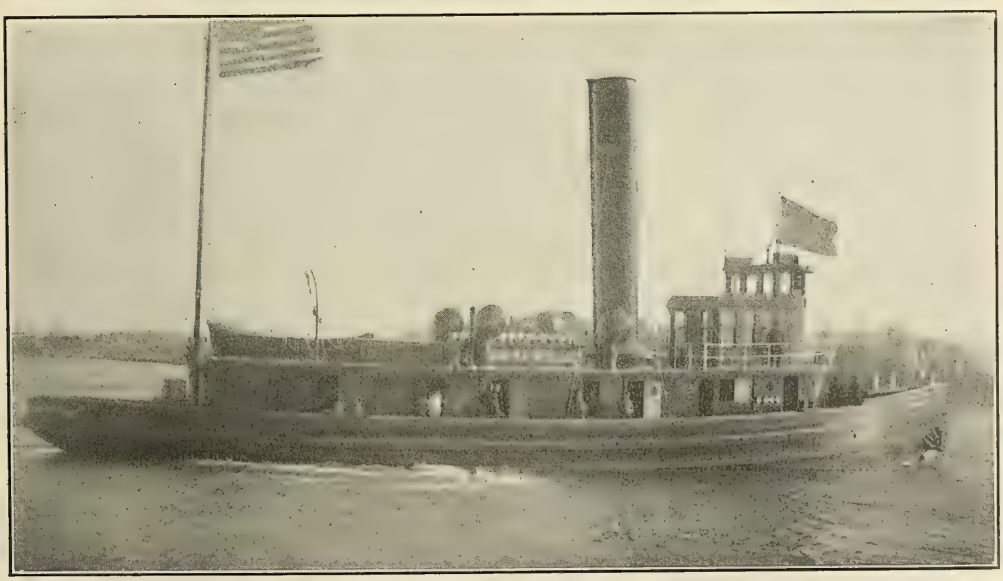
Transfer No. 21, built to the order of the New England Steamship Company by the Fore River Shipbuilding Company, of Quincy, Mass., is a single screw towboat of the following dimensions:

Length between perpendiculars.....	111 feet 10½ inches
Breadth molded	26 feet
Depth molded.....	14 feet 6 inches

In design and general appearance she is similar to existing towboats of the owners' fleet, having a towboat stern and round-up stem, with one smokestack and one signal mast. A steel deck house has been built on the main deck, and extends for about three-fourths of the vessel's length amidships, which in addition to inclosing the engine and boiler hatches, has accommodations and mess room for the crew in the afterpart and the powerful wrecking pumps in the forepart. On top of this house is a wood erection inclosing pilot house and directors' room.

The vessel has been fitted with powerful oak towing bitts and nigger heads capped with brass, and is fended all fore and aft with stout oak guards faced with steel, in addition to the usual portable hickory fenders. Provision is made for the transport of fresh water in two deep tanks in the fore and after peaks.

The propelling machinery consists of one inverted compound surface condensing direct-acting engine, with a high-pressure cylinder, 20 inches diameter, and a low-pressure cylinder of



TRANSFER TUG NUMBER 21, OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

44 inches diameter, having a common stroke of 28 inches, and designed for a working pressure of 160 pounds per square inch. Steam is supplied by one multitubular return tube Scotch boiler, 15 feet 3 inches mean diameter by 12 feet 6 inches long, fitted with three corrugated furnaces 4 feet 2 inches inside diameter.

A duplex fire and wrecking pump, 15 by 12 by 12 inches, fitted with fire plugs and wrecking suctions, the former arranged for fire gun nozzle on top of pilot house, has been installed, with all connections complete, arranged to pump from tanks, engine and boiler compartments, as well as from the sea. The usual outfit of auxiliary machinery has been supplied and fitted complete.

The vessel, during the trip from the builder's yard to New York, developed a speed of over 12 knots without forcing.

MARINE ENGINE LUBRICATION.

Under this heading three of the prominent lubricating concerns in the United States have furnished us with information regarding their own particular types, none of which is the usual fluid oil. These statements have been set down side by side, each being recognized to be partisan with regard to its own particular specialty. Along with these we are republishing an article which appeared in our columns more than four years ago, and which was written by one of the engineering officers of the United States navy. This was the result of observations during a protracted experience at sea, and, so far as we know, was totally without bias.

NON-FLUID OIL.

With the standardization of types and the adoption of well-tried dimensions and proportions for steam prime movers, breakdowns and derangements of engines are coming to be more and more referable to the one feature of design which has not kept pace with the improvements—engine lubrication. In a recent paper, the experts of the American Blower Company, Detroit, are quoted to the effect that 80 percent of the small engine troubles are due to improper lubrication; whereas, only 10 percent are due to inadequate proportions of the working parts, and the other 10 percent to the neglect or ignorance of the operator.

Particularly is this true in marine engineering, where special conditions render proper lubrication difficult under the most favorable circumstances, and the great multiplication of small engines, such as independent air, circulating, bilge, and feed pumps, ash hoists, fireroom blowers, ventilators, refrigerators, anchor and winch engines, dynamo engines and various special devices, give reliable automatic oil supply an importance out of all proportion to that obtaining in shore practice.

Though numerous enlightened systems of comprehensive design have been introduced and adopted in various forms by large shipbuilders, the greatest diversity exists on different ships, in the lubricating arrangements as well as in the choice of unguents. It may safely be said that the old style of individual oil cup, with wick tubes and wick, is still the prevalent device. Cylinders of vertical engines, as well as slide valves of the piston type, are often not oiled at all, particularly since the publication of Prof. Lewes's epoch-making paper opened the eyes of the marine engineering world to the dangers of admitting oil to the boilers through condensed feed water. Time was when no main engine was turned over without liberal injection of two or three oil pump reservoirs full of cylinder oil into the cylinders and valve chests, and each cylinder was fitted with its steam cut-off oil cups, besides the steam-operated sight feed on the high-pressure valve chest, and frequent doses through the indicator cocks whenever "she grunted," or the engineer felt that "she needed it." If no oil is used from the outset, if a slight injection is given and the cylinders are carefully drained just before "securing" the engine on coming into port, and the covers are frequently taken off to allow the cylinder walls to be swabbed out and oiled, the internal lubrication may be trusted to the effect of steam, and the use of oil be reduced to a surprisingly low amount. Nevertheless, oil cannot be wholly eliminated from the feed water, as the flat slide valves customary on the second intermediate and low-pressure cylinders do require oil, besides which a good deal is carried through the stuffing-boxes by the "swabbed" piston rods. Of grease extractors, we have tried many types, but found most of them inefficient, owing, mainly, to the positive disinclination of the oilers to renew and clean the filter pads, lufa, straw or whatever material may be used.

For crank pins the centrifugal oiler has proved very reliable. Wipers are to be execrated as wholly unsatisfactory. A great incidental advantage of the centrifugal oiler is that it permits the engineer to admit water to the pin and to locate a thump. Special devices of swinging pipes to the crosshead and crank pins, such as the Hills-McCanna, have been used to good effect. Crosshead pins are frequently supplied by telescopic oil pipes, by wipers placed at the top of the stroke, and by direct drop from wick-supplied tubes led in under the cylinder and delivering to boxes carried by the crosshead. Of all these systems the swinging tubes are most positive in action.

Despite all these actions, a great deal of the oil is thrown onto, or rather at, the crosshead and crank pins on the "hit or miss" principle, by oilers and engineers with their squirt cans. This is particularly true of the vibrating link, the valve stem and rock shaft journals, and to a lesser degree of the numerous bearings and working joints of the auxiliaries. The waste is appalling. It reaches sometimes to an extent that would seem impossible to the shore engineer. Usually the chief engineer establishes a daily allowance, which is placed in the supply tanks by the store-room keeper or donkey man. But if bearings commence to run hot, he frequently is the chief offender, literally smothering the journals in oil, increasing the allowance or taking off all restrictions.

As there is no convenient supply house within reach, thousands of miles from port, and as owners and superintending engineers are usually chary about furnishing large supplies to start with, any unusual waste of lubricants becomes exceedingly serious. More than one tramp has been obliged to break up the voyage to put into port for a new supply of oil, and it has repeatedly occurred that men-of-war were obliged to leave the blockading or cruising ground to lay in—not more coal or provisions or ammunition, but just oil.

These considerations emphasize the value of using non-fluid oils for lubrication on board ship, to increase the efficiency of oiling and in order to minimize waste. Greases and soap-solidified oils have been, and are still, used to a large extent, particularly on main bearings, spring and thrust bearings of the main engines and other principal auxiliaries.

In many ships the spring bearings of the shaft alley have open boxes, which are filled with a solid grease, through which solid brass pins are thrust to contact with the shaft, being kept in place by enlarged heads. Friction on the shaft heats these pins, causing the grease around them to flow to the journal. If the bearing should run hot—which very readily occurs with a box frequently left open by carelessness, and thus becoming a receptacle for dirt—and be not caught in time, the whole mass of grease is melted, leaving the unsupported pins to fall between the cap bearing and the shaft, where they are pinched and abraded, causing no end of trouble.

Generally speaking, soft solid lubricants should on no account be fatty oils or greases. They are commonly made by emulsifying animal and vegetable fats with soap and water, or thickening mineral oils with soap. Ordinary lime, soda or lead soaps are used, frequently containing an excess of

caustic soda, which is converted into carbonate of soda and becomes liable to cut the bearings. Another danger is that free fatty acids are often contained in such greases, which attack the metallic substances with which they come in contact, and cause glands to leak if used on rods or valve stems passing through stuffing-boxes. A more common, in fact universal, trouble with soap-solidified mineral oils is that, when the bearing grows at all warm, the mineral oil runs away, leaving the soap in the box, like a sponge squeezed dry of water. This forms a nucleus for the adhesion of any dirt or abraded metallic particles, soon making a hard, gummy mass, spreading out as a layer or coating over the shaft or pins, increasing the friction and soon inviting cutting. The best authorities recommend that greases be never used except on slowly-moving machinery. Modern transatlantic liners run up to 950 feet of piston speed, and swift power boats attain 1,200 feet per minute. This would indicate how little greases are in place on marine installations.

For spring and thrust bearings, the heavier grades of non-fluid oils are ideal, especially if used in connection with patent cups having a wire net screen and a lidded box cover. Frequently, oil is thrown off in fine drops by centrifugal action of rapidly turning shafts, which could not happen if the open boxes were lidded and closed.

These non-fluid oils, having all the advantages of the soft or semi-solid form of unguents without any of the above-mentioned defects of soap-solidified greases, offer an additional advantage peculiarly fitting them for use in main bearing compressive cups, on crank and cross-head pins, and especially for "make-up feed" supplied by hand with squirt cans. This is the property these lubricants have of adhering to metal surfaces with a force far in excess of that of regular fluid oils. Why this should be we are not able to explain. Suffice it to say that it is an undoubted fact, borne out by many tests and much practical use. This, and the considerable viscosity, cause the non-fluid oils to leave the squirt can drop by drop, instead of in wasteful streams, so that the excited oiler has a chance to readjust his aim at the elusive crank-pin cup before half of his can has been emptied into the bilge. After these oils have reached the journal, their peculiar property of adhesion to metal prevents their rapidly running through the bearing at the ends. They spread over the journal, interposing a thin film of oil between the bearing surfaces, which is ideal lubrication.

The other element of ideal lubrication is to have each drop of oil go where it is needed, and no place else. In many modern ships a comprehensive unitary system oil distribution is adopted to insure this element as far as possible. Oil is poured into a main feed tank, from which it is conveyed by gravity or under pump pressure to the various journals through suitably adapted pipes. In a recent installation, multiple box oilers with outside drop supply the cross-head guides, cross-head and wrist pins; the crankshaft bearings are oiled by compression cups, and the eccentric straps by oil and grease cups, while the cylinders and valves are supplied by sight-feed oil pumps having trip and rod connections to the engine. Though central distribution systems are growing in favor with superintending engineers, they have not succeeded in displacing the squirt can. Many old-time engineers and oilers cannot be restrained from wanting to *see* and *feel* the oil going in. They are a very conservative people. In spite of all the improvements in mineral oils, their relative cheapness and freedom from acids, the old timer would not think of leaving port without his private demijohn of —— castor oil, the standby in moments of real trouble.

Central distribution systems have been successfully fed with grease. That is to say, they were successful in having the grease reach its places of operation, though the gumming and high friction often following the introduction of grease decreased the value of these installations. But the experience shows how valuable similar systems would be for marine practice if fed with non-fluid oils, which can be made of a consistency light enough to insure their ready passage through the oil tubes, while their absolute freedom from gum precludes the possibility of their clogging the pipes—a most common and serious incident of all oil distribution systems. Forced feed types of lubricators, such as the Penberthy, can be relied upon to propel non-fluid oils to places where it is very difficult to feed through gravity cups.

A very common defect of marine oiling arrangements is the insertion of feed tubes at one end of the bearing, instead of at the middle. Even when placed at the middle, one end of the journal is often poorly supplied if the ship happens to be much down by the head or stern—a contingency from which shore plants are quite free. If the oil-feed tube is at the forward end of a journal, and the ship trims by the head to a considerable degree, it may be quite impossible to keep such a journal cool without constant hand oiling. For this condition of varying trim, non-fluid oils offer special advantages, because they do not run readily, and they do their work where they are placed, being spread from end to end of the bearing by actual wiping of the revolving journal.

An interesting comparison run was made two years ago on board the Clyde Line steamer *Apache,* using fluid and non-fluid oils. Using the same bearings for two periods of 54 hours each, it was found that 2½ pounds of non-fluid oil effected the same lubrication as 2½ gallons of fluid oil. As the cost of non-fluid oil was 10 cents a pound, the total was 25 cents (1 shilling) for the run; while the fluid oil cost 40 cents a gallon, or $1.00 (4 shillings) for the run. The test showed a saving of 75 percent on the direct cost of lubricants by using non-fluid oil. The results were so satisfactory that the Clyde Line has continued using non-fluid oils on the *Apache* ever since.

In Parsons' marine turbine engines, the two main bearings are usually kept floating in oil under a pressure of from 5 to 10 pounds. If ever the metals should come into intimate contact, the friction would soon destroy the entire machine, as the white-metal lining of the bearings would run out, throwing the shaft out of alinement, which, with the very small clearance between rotor and stator blades, would inevitably result in the two sets stripping each other. Spring bearings of turbine engines are supplied with grease and a liberal supply of water. In the thrust bearing, less trouble is experienced than with those of reciprocating engines, as the propeller thrust is counteracted by the end thrust of the steam on the turbine shaft.

Engines of motor boats are usually supplied with mechanical lubrication, having a pump feed to every point. For this class of engines non-fluid oils are particularly adapted, as the mechanical details are very similar to those of high-powered automobile engines, for which these oils have proved especially suited, being used exclusively by some forty auto-manufacturers. The parts are so many and move so fast that make-up feeding by hand squirters is quite out of the question; and any oil used must tenaciously stick to its journal until consumed, or it will be thrown off or worked out, leaving the bearing metal to metal. As these motor boats are ordinarily pleasure boats, it is especially desirable to use oils which will not splash or spatter about.

Whatever type of boat or engine be considered, one is forced to the conclusion that improvements of a radical nature on the methods of supplying oil, and in the nature of the oils used, is urgently needed in marine engineering. Says Thurston: "The art of economical employment of lubricants consists mainly in the determination of their adaptation to specific purposes, and in the application to each machine or each part of a machine on which pressure of lubricated surfaces of widely differing

amount is found of precisely that quality of unguent which is best adapted to that particular place, and, above all, applying it in the best possible way." Before becoming a professor, Thurston was a distinguished marine engineer. Considering the prevalent defects of marine lubrication, one is inclined to believe that in writing the words just quoted he must have had marine engines in mind.

G. P. Hutchins.

PETROLEUM GREASE AS COMPARED WITH ANIMAL GREASE.

Manufacturers of lubricating greases in the United States seem to have ranged themselves into two distinct and opposed classes. One class, which we shall call "Class A," puts out a grease produced entirely from animal fats; the method of applying which is based upon its power of changing consistency under increase of temperature. That is, the grease is quite solid in the cups until the heat of friction from the bearing becomes sufficiently great to melt it, and thereby enable it to flow down upon the journal.

The second class manufacture greases from mineral oils entirely, and the aim is to produce a grease that shall not change consistency under any range of temperature up to 600 degrees F. or thereabouts. The chief exponent of these principles manufactures eight separate densities of grease, ranging from a free-flowing liquid to a permanent solid. These densities are absolutely unaffected by variations of temperature within the limit named. The application is from pressure cups, and when pressure is applied the flow is uniform and certain.

Now, as to the relative economy of the two—let us consider first, Class A, the animal greases which will not flow until made liquid by heat from the bearing. We know that one British thermal unit is that amount of heat required to raise the temperature of 1 pound of water through 1 degree F. We know also that to produce this tiny amount of heat 778 foot pounds of energy are needed. When one begins to calculate, even mentally, the probable amount of heat of friction required to keep this grease flowing upon all the bearings throughout a machine shop, the fact is made clearly evident that true economy cannot lie in this direction.

A second proof of the same point is found in comparing the respective coefficients of friction obtained from the various greases, under test at Cramp's shipyard.

The lowest result obtained from any grease of Class A was 0.006, while Keystone (petroleum) grease gave a coefficient of 0.0034, thereby showing that only about one-half as much power was consumed in overcoming friction as in the first-named instance. Furthermore, it was proved that during one hour's running under severe conditions, 130.6 grams of "Class A" grease were consumed, while under similar conditions only 14.4 grams of the petroleum grease were consumed. It was shown also that, under prolonged test, the greases of "Class A" vaporized, and become so inefficient that the test had to be stopped; at no time, however, did the competing grease show any change of density or loss of efficiency.

Two tests by the chemist of the William Cramp & Sons Ship & Engine Building Company were made in 1906 and 1907 under similar but not identical conditions. In each case the test was in competition with other lubricants which are not here named. The tests were made on the Cornell oil testing machine, designed by Prof. R. C. Carpenter,* and finally adopted by the United States Government as a standard device for testing lubricants. Its essential features are a shaft and journal revolved by belt and pulleys from the power shaft; bearings, the pressure upon which may be regulated at will; a pressure indicator to register the load on the bearings; a speed indicator to give the revolutions per minute; a thermometer to register the change in temperature of the journal and bearings as the test progresses; and a scale beam on which the frictional resistance is recorded. The coefficient of friction is found by dividing the frictional resistance by the total load on the bearings.

In the first test an analysis of Keystone grease showed 0.14 percent of free fatty acids, with no free mineral acids, rosin oils, talc, graphite or clay. The sample was stated to be entirely free from deleterious substances, such as would cause its decomposition, or would have a detrimental effect upon metal surfaces. The test was conducted for one hour and thirty minutes, readings being taken after the first thirty minutes, at which time the bearings were assumed to have reached a constant temperature. The grease was fed from a hand-pressure cup of 3 ounces capacity, by applying a uniform pressure at intervals of five minutes.

This test is stated to have been characterized by the smooth running of the journal, the uniformity of its temperature and a low coefficient of friction. The total pressure on the journal was 1,500 pounds; its area was 14 square inches, and the pressure per square inch, 107.1 pounds. It was revolved at 450 revolutions per minute. During the test the temperature of the room rose from 82 to 83 degrees, the average being 82.4; the temperature of the journal rose from 160 to 174 degrees, the average being 170.8.; and the average difference between the temperature of the journal and that of the room was 88.4 degrees. The friction decreased from 10.5 to 7 pounds, the average being 8.5 pounds. Its coefficient decreased from 0.0070 to 0.0046, the average being 0.0056.

The second test was on the same journal, with a total maximum load of 3,000 pounds and a pressure per square inch of 214 pounds. The revolutions, as before, were 450 per minute. This test was continued for about two and one-half hours, readings being taken during the last two hours. The load during the first hour under observation was only 2,000 pounds, or 143 pounds per square inch. During this hour the temperature of the room increased from 70.2 to 72.8 degrees, the average being 71.2. The temperature of the journal increased from 121 to 123 degrees, the average being 122; the difference between the two averages being 50.8 degrees. The friction decreased from 9 to 7.2 pounds, the average being 7.8 pounds; while the average coefficient of friction was 0.0039.

During the last hour, with a load of 3,000 pounds, the temperature of the room increased from 70.2 to 72 degrees, the average being 73. The temperature of the journal increased from 124 to 138 degrees, the average being 133.75. The difference between these two was 60.75 degrees. The friction decreased from 10.9 to 9.5 pounds, the average being 10.2 pounds. The average coefficient of friction was 0.0034.

W. R. McLain.

FLAKE GRAPHITE.

The conditions of marine engineering are, as we all know, different from those of stationary engineering. In marine work the first necessary consideration is that the working units must be confined in as small a place as possible. The units must be worked in varying stretches of 24 hours each. There are no emergency units that may be thrown in, in case anything goes wrong. The load is fairly constant, a steady, long, hard pull. There is no chance to shut down for repairs. Railroad men tell us that the life of the locomotive is very much prolonged if it can have an intermittent run, rather than a long, steady one. We may judge from this what a strain marine service puts on an engine.

Friction.—Wherever there is a mechanical movement, friction has to be overcome. This is done by interposing between the moving parts a substance which will separate the parts from each other (and has the least friction in itself). There

* Cornell University, Ithaca, N. Y.

are three general classes of lubricants used—fluid, semi-fluid and solid. The writer will not attempt to discuss fluid or semi-fluid lubricants, because this is a subject which would cover many chapters, but will point out a few of the disadvantages of fluid lubricants for marine service, particularly in regard to steam engine cylinder lubrication.

Oil in steam engine cylinders, as many marine engineers have said, is a very "great curse," it being impossible to separate all the exhaust steam. As a consequence, some will find its way back into the boilers. The disadvantages of oils in a boiler are:

1. They have a tendency to attach themselves to the hottest places.

2. They are poor conductors of heat, and if there is any scale-forming material in the water it will collect.

3. If the oils contain impurities a chemical change will occur (especially in the presence of superheated steam), forming a destructive emulsion.

Solid Lubricants.—Anything which will reduce the amount of oil consumed, or entirely obviate its use in cylinder lubrication, is welcomed by the progressive steam engineer. A lubricant that has proved successful in this particular is flake graphite. The many qualifications of a perfect lubricant possessed by flake graphite especially adapt it for all lubrication, particularly in marine work.

It is unaffected by any degree of superheat or cold encountered in any class of lubrication. It will not gum, leave a sediment or injure the working surfaces. It is a good conductor of heat. It will stand the greatest load per square inch, with a marked reduction in friction. It does not offer the resistance to motion that is inseparable from the viscosity of an oil or grease that would stand like pressure.

If a metal, no matter how carefully polished, is examined under a microscope, it will be found to contain many small irregularities—the real cause of friction.* It is the scraping of these irregularities, one over another—the constant cutting or wearing—which is so productive of hot boxes, cut valves and cylinders.

The thin, tough flakes of graphite attach themselves to and build up these irregularities, filling in the low spots and forming over all a thin, impregnable, veneer-like coating of marvelous smoothness. When a sudden lurch or pitch comes, this graphitic coating will keep the metal surfaces from coming into contact with each other, and prevent the damage which might be done before the lubricator could deliver more oil.

Flake graphite may be introduced to the cylinders either with oil or by condensation of steam. It has no injurious effect in the boilers if some escapes the condenser and gets carried back. It will be a benefit rather than a detriment, as the flakes will become attached to the metal surfaces and prevent pitting, keeping foreign matter from taking hold. The heat transfer will not be affected, for graphite (as before stated) is a very good conductor of heat.

Semi-solid lubricants should be used wherever practicable, and have the following advantages over oils:

1. They are used only as needed, and form a protecting collar, after doing their work, which will keep dirt and grit from working into the bearings.

2. They are more cleanly than oils.

3. The fire risk is very much reduced.

4. They are cheaper than oils.

Care should be exercised, however, in selecting these, as they should be adapted for the work. Their lubricating value is always increased by adding flake graphite (it is always better to use graphite greases which are compounded by some reliable company, as they will be found to contain correct proportions of graphite for the work required of them). Tests by the late Prof. Thurston, Prof. Kingsbury and Prof. Goss, all show that friction is reduced by adding flake graphite. These tests have more than been proved by engineers. A well-known commander in the United States navy said:

"One of the first orders I gave on joining this ship was forbidding the use of oil in any of the steam cylinders, and to enforce this order I had all the oil cups removed from the steam pipes leading to the cylinders, so that it was impossible for the men to use oil. When these cylinders were examined, at intervals of from three to six months, I simply had them wiped out with a little waste and saturated with vaseline and graphite; and I must say that I have never seen the cylinders and piston rings in better condition than they were on this ship during my three years' tour of duty.

"I made a personal examination of the different cylinders whenever they were opened, and they were in perfect condition—never so much as a scratch—the walls being as smooth as mirrors. I can safely say that the use of graphite alone in steam cylinders gives excellent results, for if oil is used the oil goes through the exhaust into the condenser, and into the boilers and forms an acid, which attacks the metal of the boilers and causes them to deteriorate very rapidly."—*Graphite,* March, 1907.

L. H. Snyder.

* It is related how a convict cut the bars of his cell window by using a piece of yarn and fine sand dust, the whole wetted by saliva—illustrating how much damage may be done to bearings by the lubricant being laden with metal particles.

Internal Lubrication of Marine Machinery.*

BY H. C. DINGER, LIEUT. U. S. N.

The loss due to the friction of pistons, plungers, valves and their respective rods at stuffing boxes forms a large part of the total loss caused by friction; and the question of keeping these internal parts in proper condition to reduce this loss to a minimum and prevent their wear warrants considerable attention by those to whom the care of marine machinery is entrusted. New difficulties in lubrication have been met in the use of high steam pressures and superheated steam, due to the very high temperature at which the ordinary lubricants are vaporized. The use of greater piston speeds and pressures on wearing surfaces likewise has added to the problem.

Remedies suggested to secure the nearest to the desired conditions are:

1. Selection of best materials, the friction between which is a minimum.

2. Efficient design.

3. Good and accurate workmanship.

4. Care and treatment to prevent the deterioration of the wearing surfaces.

5. Lubricants.

PROPER MATERIAL.

The materials for the internal wearing parts should be such that the coefficient of friction is as small as possible. Then a very smooth and hard surface can be obtained, and one that requires relatively little lubrication besides the moisture of the steam. Hard, cross-grained cast iron, wearing on itself, seems to meet these conditions better than any other practical combination of metals. When the cylinder and valve-chest liners are made of this material, and with cast iron rings well fitted, an extremely hard and smooth surface is the result, without applying any lubrication but the moisture of the steam. The material should be as hard as it is possible to work it, the efficiency of the wearing surface depending in a great measure on its hardness.

EFFICIENT DESIGN.

The following points of design will affect smooth running very materially:

The spring rings or snap rings should exert a uniform and not an excessive pressure, and their surfaces should not be

* Reprinted from page 503, October, 1903.

too great. Thus, if a ring 1 inch wide will be efficient in keeping a piston tight, making the ring 2 inches will only add friction.

Fitting relief rings on slide valves, and balance pistons on piston valves, always reduces friction, and is the general practice of to-day.

The framing and other parts of the engine must be properly braced and stiffened to guard against vibration and the movement of the ship.

The stuffing-box packing should be designed to allow some side play, so as to follow the rods when they become somewhat out of line.

WORKMANSHIP.

Good workmanship will insure all parts being in line, all surfaces true and all parts accurately fitted together. This includes boring the cylinders true and finishing the valves and seats to a true surface and the rods to a uniform section. If there are any material discrepancies in these points good results cannot be expected to follow.

CARE OF SLIDING SURFACES.

This is accomplished by keeping all parts in line, preventing rusting, pitting and scoring of cylinders, flats in rings or rods, and cutting of all wearing surfaces.

If the cylinders or rings are allowed to rust the true surface is at once destroyed, and small particles of rust will grind and cut away the wearing parts. Rusting in the cylinders is caused by the presence of both air and moisture. Moisture may be removed by well draining the cylinders and all steam pipes connected therewith; by the avoidance of pockets that cannot be drained of water, and by running the condenser for some time after the engines are stopped, so that all possible vapor is drawn out of the engines. When an engine has thus been efficiently drained, the low-pressure exhaust should be kept closed, especially if the condenser is to be run at any time. In case there is no exhaust valve, and it is desired to run the condenser, it is advisable to put the low-pressure valve on its center, and thus prevent the vapor from the condenser from backing into the cylinder and causing rust. Leaky stop and throttle valves will, of course, present conditions to allow rusting.

To keep out air, all parts of the engine should be kept closed. Close the drains which open to the atmosphere, indicator cocks, etc., as soon as the engine is shut down. The cylinders of auxiliaries are most likely to suffer from rust, due to leaky or partly closed valves, open drains and the presence of various pockets where water can collect.

When engines are to stand unused for more than a couple of days, and after any lengthy run, the cylinders should be opened and wiped out with kerosene. This removes all rust, moisture or other deposits that may have collected. Then adding a coat of vaseline will protect the surfaces from further rust or corrosion, as well as give them a good lubricant.

Pitting in cylinders and internal surfaces is caused by acids which may be contained in impure oil, or from the action of oily deposits consisting of dirt, oil and rust. Air, collecting in pockets and becoming heated, may also cause this.

Scoring is caused by hard particles left in the cylinders and by the edges or ends of the rings nipping the cylinder walls, resulting from countersunk bolts let in too far, shoulders worn in the cylinder when the piston does not overrun, or rings overrunning counterbore, due to lack of adjustment. Slightly rounding off the edges of the rings might prevent nipping, and providing efficient keepers for the ends will prevent the ends from vibrating or the rings from nipping the walls. Excessive pressure on some parts may cause the surface to abrade and produce a flat. If the rings do not fit well, the wear will be only on certain portions; for although the ring in a manner adjusts itself, yet when moved at all the fit becomes worse than ever.

The piston rod being out of line will also cause excessive wear on one side of the cylinder and piston rod. When boilers foam, particles of dirt contained in the boiler water pass into the engines, and there raise havoc with all moving surfaces.

LUBRICANTS.

Vegetable or animal oils must never be used, on account of the acids, which, being easily driven off by heat, cause corrosion in the boilers. Mineral oils are largely used, but have a bad effect on the heating surface of boilers, causing lack of efficiency, burning, etc. Oils too freely used also cause piping, pump valves and seats to deteriorate, joints in piping to leak, condensers to become less efficient on account of oily deposit, and in general cause an increase in repairs and falling off in economy.

With very high pressure or superheated steam ordinary oils are vaporized, or at least their lubricating value is greatly reduced, so that, as in the case of gas engines, lubrication has become a most important question. When somewhat moist steam is used, the moisture in the steam acts as a lubricant, especially with cast iron. With parts well fitted and steam not too dry, vertical cylinders will run satisfactorily without any lubricant except that applied when the cylinders are opened; but a satisfactory lubricant will very materially lessen the friction and wear.

Flake graphite has the peculiar properties of not being affected, either chemically or physically, by any temperature encountered in a cylinder. It is not easily carried away from the wearing surfaces, can stand any pressure, and requires only an infinitesimal clearance space between surfaces. It has a high lubricating value, and hardens and improves the wearing surfaces by filling up all the minute cavities and irregularities in the surfaces, giving, in a short time, a beautiful, hard-polished surface, which requires relatively little lubricant.

Graphite may be applied in the following manner: Whenever cylinders or valves are overhauled, mix graphite with vaseline before applying to the surfaces, which insures a general distribution. On starting up, introduce graphite through an oil cup or indicator pipe. This can be done in a dry state, using an oil syringe, or the graphite can be mixed with water and put in just like oil. Adding it to cylinder oil adds to the lubricating value; but if best results, viewed from the standpoint of boilers and condensers, as well as engines, are to be obtained, no oil should be introduced into any steam cylinder on board ship. While running, graphite can be added in the same way; but very little is needed, since it quickly distributes itself over the surfaces and, unlike oil, it remains there. Whenever there are indications of the cylinder walls "squealing" a little graphite should be added. Some cylinders lubricated in this manner, that have not had a drop of oil introduced for years except that which might have come from swabbing rods, on being opened are found perfectly smooth and as bright as mirrors. The surfaces have a very fine coating of graphite, which keeps them from being dry and prevents abrasion.

The same results are obtained with valves and their seats—the surface is made smooth and hard, scores are filled up, and a tight and easily worked valve is the result.

In order that the piston rod may work with little friction in its stuffing-box it must be well lubricated. Most patent metallic packings have an oiling arrangement, but this should be supplemented by swabbing the rods. The addition of a little graphite to the stuffing-box cylinder oil will greatly improve its lubricating value, and also serve to develop a hard and smooth surface, which is so essential to steam-tight working.

The packing that allows for side movement will keep the

rod from wearing, and preserve a tight joint, much better than those which do not allow such play. Small rods, such as valve rods and rods of auxiliary engines, which in many cases have no separate oiling device, should be swabbed to prevent cutting, or the wearing of the rod to a flat or taper, as well as to reduce friction. The primary feature of keeping a stuffing-box tight is to keep a true cylindrical rod, and the peculiar properties of graphite produce a hard and smooth surface.

The small and often delicate secondary valves of steam-pump valve gear are made to fit quite tight, and often they become hot and dry and consequently stick. If oil is used in these, it gums on the surface, and this causes the valve to stick. Slight rusting also causes cutting, which interferes with proper running. The best treatment for these parts is: (1) Frequent overhauling, wiping off all parts with kerosene to clean, remove and prevent rust, and supplying graphite to protect and develop the wearing surfaces. (2) Adding a small amount of kerosene with graphite added occasionally or when the valve does not work properly. Kerosene serves to cut out and prevent rust; it has also no bad effect on the heating surface of the boiler.

It is often stated that pumps will not run without oil, but it is a fact that pumps using oil do not run as well as other pumps in which nothing but a little kerosene and graphite has been used for a long period.

WATER END OF PUMPS.

The lubrication of the water cylinders of pumps is frequently entirely overlooked. A great many pumps receive their lubrication naturally, as in the case of air and feed pumps, from the oil in feed water; bilge pump, from the oil contained in the bilge. But those pumps working on clean salt water—sanitary, distiller and auxiliary condenser circulating pumps—do not have these sources of lubrication. Salt will deposit itself in some degree, and is at once a cutting agent to plungers and pump cylinders.

Such pumps can be lubricated by placing a little grease, mixed with graphite, on top of the glands. This at once lubricates the rod, and some of the lubricating material will find its way to the surface of the cylinder, thus reducing friction and wear. The abnormal wear of plunger rods working in clean salt water may have often been observed.

These notes are the results of observation and investigation of sea-going experience, and, as such, view the matter from a practical standpoint. There is no doubt that if the question of internal lubrication were well considered and investigated by those operating marine machinery, great reductions in overhauling, wear and tear, and anxieties in attendance would result.

The Merchant Tonnage of the World.

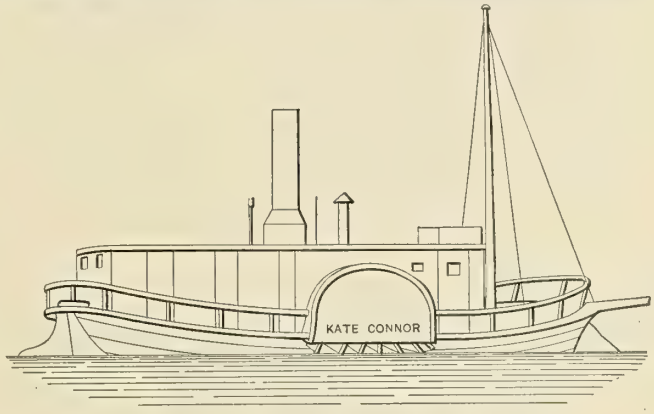
According to *Bureau Veritas,* the total number of sailing vessels of 50 tons and upwards afloat Jan. 1, 1908, was 25,879, with a total net tonnage of 7,245,608. One year ago there were 26,579 vessels, with a net tonnage of 7,550,273, and 27,122 vessels two years ago, with 7,620,679 net tons. There is thus seen to be a steady decrease in both number and tonnage, the loss in tonnage in two years having been 375,071, or about 5 percent. The average size has decreased from 281 tons in 1906 to 280 in 1908, having been 284 in 1907.

The number of steamers of 100 tons and upwards afloat at the present time is given as 14,985, with a gross tonnage of 32,169,350, as compared with 14,656 vessels of 30,256,336 gross tons one year ago, and 14,018 vessels of 28,369,140 tons two years ago. This shows a gain in tonnage in two years of 3,800,210, or 13.4 percent. The average tonnage has risen from 2,024 in 1906 to 2,065 in 1907 and 2,147 in 1908.

The First Steamboat on Great Salt Lake.

In the fall of 1868, General P. E. Connor, who had previously been in charge of the government station and troops near Salt Lake City, obtained a contract with the Union Pacific Railroad, which was then building, for the supply of ties. The road ran around the north end of Great Salt Lake, where there was no timber (nor, in fact, anything else), and the ties were obtained from the mountains south of the lake, a distance of about 85 miles, from shore to shore.

His proposition was to load the ties on flatboats, and tow these over and back by a steamboat, leaving the flatboats for loading and unloading, and keeping the steamboat continually



THE IMPROVISED PADDLE STEAMER KATE CONNOR.

at work. Accordingly, he employed a London boat builder, G. Haywood, of Salt Lake City, to build the steamboat, which was 55 feet long and 18 feet beam, with 5-foot guards.

The boat was propelled by paddle wheels, with an engine consisting of the steam end of an old steam pump, geared to the wheel shaft. A boiler was obtained from San Francisco. The machinery was put in and arranged, and the boat run out of the river by the writer. She was called the *Kate Connor,* after a daughter of the proprietor. She started on Dec. 11, 1868, and ran across the lake to her depot at the south end on the following day. She afterwards had a larger engine and boiler put in, and made a number of trips across the lake in 1869, but was not a financial success.

As an illustration of the paucity of resources at that time, the engine had no globe valve, and such a thing could not then be obtained in the territory. Eventually a 2-inch brass plug cock, which had been brought in for the sugar works, was found, and purchased for $15, and used as a throttle valve.

Wm. J. Silver.

At the annual meeting of the American Ship Windlass Company, recently held in Providence, R. I., Robert S. Riley, who for the past year has been the general manager of the company, was elected its president. The reports submitted showed a satisfactory condition of affairs, and the company voted to ask permission from the State Legislature to increase its capital stock from $100,000 to $200,000 (£20,550 to £41,100).

The American scout cruiser *Chester,* propelled by Parsons turbines, recently made a trial trip record of 26.52 knots for four hours. Her sister ship *Birmingham* (reciprocating engines) made 24.32 knots on a similar trial. Both were tried at 3,750 tons displacement, with loads including 475 tons of coal, the bunker capacity being 1,250 tons. This compares with a normal coal supply of 160 tons on the eight British 2,900-ton scouts, and with a bunker capacity of but 380 tons. These eight vessels made trial speeds ranging from 25.02 to 25.88 knots.

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Lubrication.

All machinery requires a certain amount of lubrication, in order to keep the parts in moving contact from scoring each other, or from becoming heated in service. The extent and character of this lubrication depend entirely upon the size, character and relative velocity of operation of the parts in question, and have to be determined upon, in general, for each particular case separately.

Many different kinds of lubricants are used, some of which, while excellent for one class of service, are totally unsuited to other work. Thus, the lubricant which is used for a fast-running spindle is necessarily thin and light; while that used for a heavy and slow-running journal, particularly where great pressure is employed, must necessarily contain much more body than the other. In the early days of marine engineering it was quite usual to employ fats and tallows to keep the parts working smoothly. In the present days of high pressure and great powers, to say nothing of high temperatures, these early lubricants are totally ruled out of court and mineral substances substituted.

The most prominent lubricants at present in use in the marine service may be divided into fluid and non-fluid mineral oils, greases of various types, and, for heavy uses particularly, flake graphite. In another column will be found a series of papers prepared for us by advocates of several of these kinds of lubricant, which we are publishing side by side, with the idea that a brief discussion of the various points of the several types may be of benefit to our readers. Each paper has, necessarily, its own personal bias; but the group, as a whole, may be said to represent, fairly, general practice on the subject, and not to be in the interests of any one manufacturer.

The Turbine Engine.

In another column a correspondent has taken up the ever-present subject of the relation between rotary and reciprocating prime movers, from a point of view which, to many, will doubtless be novel. It is quite apparent from his paper that he has some lingering sympathy for the reciprocating engine. In fact, while not in the least discrediting the turbine or the splendid results which have been achieved by it, he points out that, were equal refinement resorted to in the designing and construction of the steam engine of the piston type, equally good results would be achieved. The subject is one of great interest, particularly in view of the present prominence of the turbine question, and is one which presents many points which might well be worth looking into.

When it comes to a question of weights, however, always assuming that we are designing for a considerable speed, the subject takes on a totally different aspect; for it is quite possible to build turbines of very good efficiency, and high adaptability to the particular circumstances of the case, which will, in general, weigh markedly less than the reciprocating engines which they displace. In each case the very extremity of economy of fuel consumption will demand great weight, whether the turbine or the piston engine be employed; but for equal results, it seems to be established, beyond the peradventure of a doubt, that the steam turbine is without a peer for large powers when it comes to a question of weight.

The balancing of a steam engine of the piston type may frequently be done to such a high degree of refinement that vibration is reduced to a minimum. In this respect the turbine, as usually built, is also a splendid device. In either case, the operation of the propeller will throw masses of water against the stern as the several blades in their rotation approach the ship, and the vibration caused by this continual bombardment of the hull by relatively small masses of

water is bound to make itself felt, especially in the neighborhood of the portion affected. The propeller is intended to discharge, directly aft, all of the water which comes to it, and upon which it has acted. No propeller does this in practice, some of the water being thrown out sidewise by centrifugal action; and just so far as the propeller fails to impart complete astern motion to this water does it fail in the best efficiency of which it might otherwise be capable. The ill effects are thus double—a loss in propulsive effect and an augmentation of the causes of vibration, affecting the whole resonant structure of the ship. This feature of the subject is taken up in one of our clippings this month, in which a certain discontent is referred to regarding the fact that the large turbine vessels crossing the Atlantic are not so totally free of vibration, especially near the stern, as some people had expected they would be. So long as the propeller maintains its present form, it will probably be totally out of the question to do away entirely with something of this sort, even though the engine itself be so perfectly balanced in all its working parts that not the slightest amount of vibration can be traced to this source.

Shipbuilding Details.

Shipbuilders, as a rule, are very secretive people. It is difficult to obtain, in most cases, anything of a thoroughly technical character regarding either ships or their machinery, and the few instances in which the builders are sufficiently open-minded to give out information of this sort are so relatively rare as to stand out sharply by way of contrast. Occasionally, however, something of the sort is available, either directly from the shipbuilder or from a naval architect who has developed the plans, which are later put into execution by an establishment with which he is not officially connected.

A very good example of the latter class will be found this month in the description of two steam lumber schooners, built on the east coast of the United States for service in Pacific waters. These vessels are small, and, were it not for some rather unusual features in their construction and equipment, they would scarcely call for more than passing comment. We have been enabled, however, through the courtesy of their designer, to place before our readers some splendid details in drawings and text, showing the methods of construction of a type of vessel which is becoming quite prevalent in the particular trade for which these two were designed. These details are much more extensive than it is usually possible to obtain regarding any ship structure, and, as such, are all the more valuable on that account. It is frequently possible to obtain general hull drawings of a vessel under description, and we even occasionally find available a 'midship section showing the principal scantling members. In some cases, however, these members themselves are not available, though the 'midship drawing, denuded of them, may come to hand. In only a very few cases is it possible to get such detail as has been furnished us in the instance under consideration.

It is only natural that a shipbuilder who has devoted time and energy, as well as capital, to the establishment and upbuilding of a shipyard and certain methods of construction, should wish to jealously guard all such items of detail from his competitors. In many of the cases, however, much information of value could be divulged without going into the region of the particular practice and special secrets of the establishment, and without much effort on the part of the shipbuilding establishment itself. It is very rare, however, to find such an establishment willing to give out even that which could be given without exposing their trade methods of construction; and this seems to be part of a legacy of secretiveness which has been carried along through the years as a portion of the assets and policy of the establishment. It is much to be regretted that such is the case, because the history of civilization has proved, time and time again, that the most direct and most valuable advances have come through a free interchange of ideas, and the adaptation of one method of producing the desired result where others, perhaps, have been tried with only indifferent success. It is perfectly easy for any one interested to learn nearly everything of value which his competitors are doing, even to the matter of details. Given the will, the way will certainly be found. This makes it all the more inexplicable why so much reticence should be observed with regard to the most fundamental features of a given structure.

In some cases this reticence is carried to an extreme limit, as, for instance, in the case of one firm to which we wrote, asking for the cylinder diameters and strokes of the propelling engine and a number of auxiliary engines in a vessel which they had constructed. Even such usual and general data as this were refused us, owing, apparently, to an iron-clad rule not to divulge anything which could possibly be of service to any other member of mankind, even though this service might not be in the slightest degree a detriment to the establishment in question. It strikes us that this policy, when carried to such extreme limits, is totally wrong, and that very little can be adduced in its favor. It is possible that, in some cases, a confidence may have been broken, and that an event of this sort has predisposed the managers against any sort of publicity other than that of glittering generalities, with which the daily newspapers delight to deal. As a general proposition, however, the shipbuilder will find the technical journalist entirely willing to go hand-in-hand with him—to respect whatever confidences may be imposed—and to give out no more in the way of information than the builder is willing to have made public.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports, Feb. 10, 1908, the following percentage of completion of vessels for the United States navy:

	Tons.	Knots.		Jan. 1.	Feb. 1.
BATTLESHIPS.					
Idaho	13,000	17	Wm. Cramp & Sons	94.12	95.9
New Hampshire	16,000	18	New York Shipbuilding Co	95.3	97.8
South Carolina	16,000	18½	Wm. Cramp & Sons	33.76	36.4
Michigan	16,000	18½	New York Shipbuilding Co	37.9	41.6
Delaware	20,000	21	Newport News S. B. & D. D. Co	7.05	9.2
North Dakota	20,000	21	Fore River Shipbuilding Co	12.7	17.5
ARMORED CRUISERS.					
North Carolina	14,500	22	Newport News Co	96.	97.
Montana	14,500	22	Newport News Co	91.31	93.4
SCOUT CRUISERS.					
Chester	3,750	24	Bath Iron Works	95.15	96.2
Birmingham	3,750	24	Fore River Shipbuilding Co	93.71	96.2
Salem	3,750	24	Fore River Shipbuilding Co	92.09	93.9
TORPEDO BOAT DESTROYERS.					
Number 17	700	28	Wm. Cramp & Sons	0.0	4.5
Number 18	700	28	Wm. Cramp & Sons	0.0	3.8
Number 19	700	28	New York Shipbuilding Co	3.4	5.1
Number 20	700	28	Bath Iron Works	0.0	2.5
Number 21	700	28	Bath Iron Works	0.0	2.5
SUBMARINE TORPEDO BOATS.					
Cuttlefish	—	—	Fore River Shipbuilding Co	99.	99.

ENGINEERING SPECIALTIES.

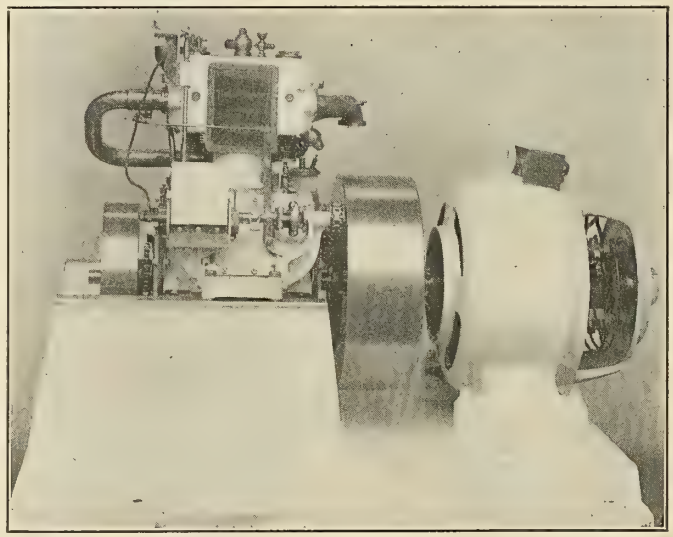
A Six-Cylinder Three-Hundred-Horsepower Motor.

The engine illustrated is placed upon the market by J. W. Brooke & Company, Ltd., Adrian Works, Lowestoft, and is designed to develop in six cylinders a total of 300 brake horsepower. Each cylinder is cast separately, with mechanically-operated valves placed on opposite sides. The engine is fitted with a high-tension magneto and high-tension synchronized ignition. The crank chamber is of cast steel, made in halves, and bolted together in the center for facility in machining. The crank shaft, which is 3¼ inches in diameter, is of nickel steel in one piece, and runs in bush bearings located between the successive dips. Two cam shafts are employed, one on either side of the engine, our photograph showing the admission valve side.

The cylinders are 10 inches in diameter with an 8-inch stroke, and are of cast iron. To economize space they are set askew on the crank chamber. Starting is facilitated by means of a one-third compression release device, and it has been found in practice that the engine will start in this way very readily. After once under way the full compression automatically comes into operation. One carbureter is employed for the six cylinders, this having been found preferable to using a separate carbureter for each cylinder. A metal-to-metal clutch is provided, operated by a lever. Lubrication is automatic.

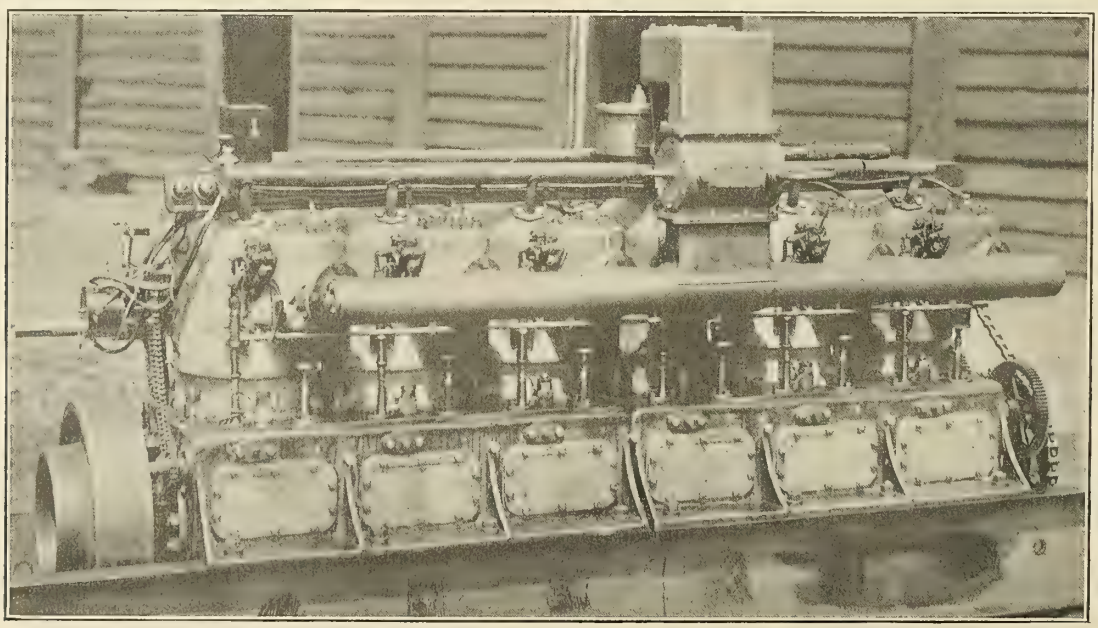
A Small Lighting Set.

The set illustrated is made by John I. Thornycroft & Company, Ltd., London, and consists of a small generator direct connected to a 6-horsepower petrol (gasoline) engine. This engine has a single cylinder, 4¼ inches in diameter, with a stroke of 5 inches, and is designed for operation at 1,000 revolutions per minute. It is especially suitable for use with



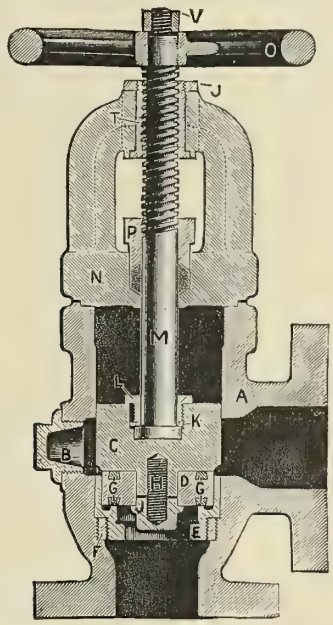
paraffin (kerosene), on which the brake-horsepower is stated to be 5.

The same motor, with slight modifications in the base, has been developed for the propulsion of small boats, but in its present illustrated form it is of particular interest, because of its simplicity and effectiveness as an outfit for lighting sailing vessels, motor and other yachts, and country houses.



An Improved Blow-Off Valve.

The cut illustrates an improved design of blow-off valve, which embodies a number of important features highly appreciated by users. Heretofore the seat has been so located that, as the disk approached it, there would be an accumulation of scale and sediment. The effect of this has been to cut out the bearing surfaces to such an extent that in a short time the valve becomes leaky. Various methods have been invented whereby the disk would fit tightly in the valve body, the object being to prevent the scale from passing on to the seat bearing after the disk had passed and cut off the inlet. This method, however, has not proved satisfactory, as the valve soon wears, and in a short time permits the passage of scale and sediment. These defects are said to have been overcome in this design. The plug fits snugly in a separate



and easily removable bronze casing, which can be readily replaced when worn. Any accumulation of scale or sediment that might remain on the seat, before the disk is brought in contact with it, is washed off by the water which passes around the plug when seating.

It will be seen that the plug *C* carries a reversible, double-faced disk *D*, secured to the plug by stud *H* and nut *J*. This plug is guided perfectly in the valve body *A*. The bronze seat ring *E* is screwed into a second brass ring *F*, the object being to make it possible to renew *E* very easily in case it becomes worn. At the back of the valve is a plug *B*, the use of which is to permit the introduction of a rod to clean out the blow-off pipe when desirable. The stem *M*, which raises and lowers the disk, is held in place by lock-nut *L*, which is prevented from unscrewing by non-rotating washer *K*. The threads of the stem operate within the bronze bushing in the top of the yoke, which bushing can easily be removed. The disk, having two Babbitt-faced bearings *G G*, can be replaced at small cost, or the user of the valve can melt out the old Babbitt and pour in new metal, and after this is faced off the disk is as good as new.

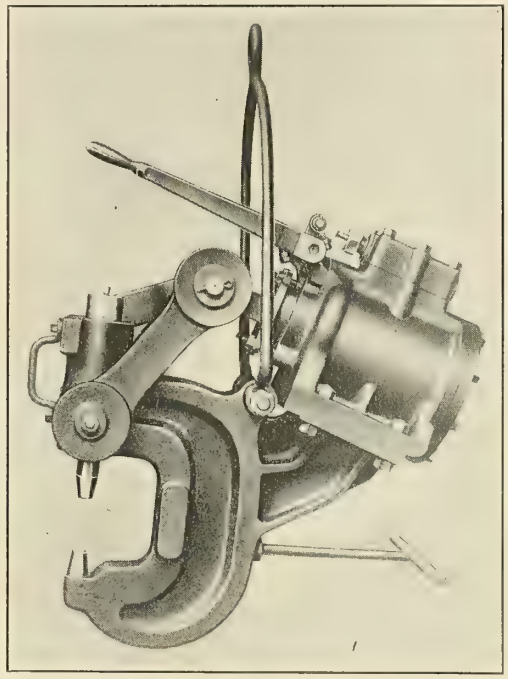
The valve, known by the trade name "Duro," is constructed and carefully tested by the Lunkenheimer Company, Cincinnati, Ohio, who claim for it extreme durability.

A New Albree Portable Riveter.

Where the work is heavier than the tool it is much more convenient and economical, if not absolutely necessary, to keep the work in a stationary position and use a portable tool. This practice is particularly desirable in riveting heavy and unwieldy structural and boiler work. The hydraulic riveter is not practical for this service, on account of the difficulty of providing high-pressure water lines and carrying away the exhaust water. An air-driven machine, however, similar to the one shown in the illustration, which is manufactured by the Chester B. Albree Iron Works Company, Allegheny, Pa., is admirably adapted for this work, as the air is conveyed to it by a rubber hose, and the exhaust takes place directly into the atmosphere.

The riveter illustrated has a 6-inch reach, will drive a ⅞-inch rivet, and weighs 850 pounds. When desired this machine may be equipped with the maker's universal bail, which will hold it suspended in any position. It will be noted that only a comparatively small cylinder is used, the necessary pressure being obtained by the toggle leverage shown, and as the rivet is driven by one squeeze the number of rivets the machine can drive is practically unlimited. Therefore, the amount of riveting that can be done is merely a question of getting the machine from one rivet to the next; in other words, the cost of riveting is almost entirely the cost of moving the machine.

To show what has been done with such a machine, under favorable circumstances, the astonishing record of 12,000 rivets



driven in ten hours' time is claimed. The work was a long plate girder, and the machine was suspended from a trolley on an overhead runway. The operator, with practice, had become very expert in moving the machine from one rivet to the next, the spacing being equal, and several heater boys keeping the holes ahead of the machine full of hot rivets. The rivets were ¾ inch diameter and driven hot, and the dies were replaced by cool ones at given intervals.

TECHNICAL PUBLICATIONS.

Massen-Distillation von Wasser. By Ludwig Bothas. Size, 5½ by 8¾ inches. Pages, 53. Figures, 8. Berlin, 1908: Julius Springer. Price, 2 marks.

This little work is divided into five sections, covering respectively the different methods of cleansing water; the construction and operation of water distilling plans; the conversion of distilled water to railroad service; the drinking water distilling plant of Baku; and an appendix giving a

bibliography of distilling plants and a number of illustrations.

The subject is taken up from the points of view of filtration, sterilization, distillation and chemical cleaning, and is based largely on Russian practice, the author being one of the government public works officers in St. Petersburg. In the specific case of the description of the plant at Baku, a population of 200,000 inhabitants is supplied with good drinking water in a portion of Russia where atmospheric precipitation is rare, and rivers and good springs in the neighborhood are entirely lacking. This has made it necessary to make use of water which, without treatment, would be totally unfit for drinking, and the results are said to have been entirely satisfactory with regard both to the chemical composition of the water as altered, and its adaptability to household uses.

The Naval Pocketbook. Edited by Geoffrey S. L. Clowes. Size, 3½ by 5 inches. Pages, 966 + xl. Numerous illustrations. 1907, London: W. Thacker & Company, 2 Creed Lane, E. C. Price, 7/6 net.

This is one of a series of annual volumes dealing with the navies of the world, and giving a vast amount of information regarding the individual ships of which those navies are composed. Beginning with the British navy, the various other fleets are arranged in alphabetical order, and under each heading the ships are grouped according to types and dates, battleships preceding coast defenders, after which come armored and protected cruisers, torpedo gunboats, destroyers and torpedo boats. The details given include the main dimensions of the ships; displacement; power; speed; coal capacity; in many cases details of the engines and boilers, such as the cylinders and heating and grate surfaces; a statement as to the armor protection for both the hull and the battery; a detailed outline of the battery itself; and in some cases certain portions of the weights, as of hull, armor, etc. Trial-trip results are given in many cases, as well as designed powers and speeds, and the whole work is annually revised and brought as nearly as possible up to date.

In addition to the lists of ships, etc., there are tables of heavy and light guns used in the various naval services, the particulars including the size, weight and length of gun, weight of projectile and powder charge, and such ballistics as the muzzle velocity, energy and perforation in wrought iron. A very complete table of the drydocks of the world, arranged in geographical order, follows; and there are a number of minor tables, for the conversion of measures, including trial-trip tables, etc.

The last section of the book consists of 136 pages of illustrations of the principal war vessels of the different powers. These are all line drawings and show the general distribution of battery and armor, there being in each case both an outboard profile and one or more deck plans. These are carefully drawn to scale, and are believed to be quite reliable. In each case only one ship, of course, of a given type is illustrated, unless there are important differences between such a ship and its sister ships. The number of ships illustrated is 136, but as each illustration serves to show the characteristics in general of from three to as many as ten ships, it might be stated that somewhere in the neighborhood of 500 of the most important vessels are here represented.

A History of the United States Navy. By John R. Spears. Size, 5⅜ by 8 inches. Pages, 334 + xii. Illustrations, 22. New York, 1906: Charles Scribner's Sons. Price, $1.50 (6s.).

This history is compressed within the limits of a convenient volume, and deals more with details of the various naval actions in which the United States vessels have fought at various times than with the details of material development, such as would be found in a more technical treatise. The latter features are not passed over without attention, but the main idea seems to have been to present a history from the point of view of a narrative dealing with action, rather than with the results of study of types of ships and distribution of guns. The preface states that "it was in the belief that every history of the United States navy claims attention first of all as a hero story that this one was written."

Some consideration has been given to the facts and conditions which have from time to time created public sentiment in favor of the employment of the navy, or against it. Of particular interest in this connection is the story of the building of a navy to throw off by main force the thraldom under which, over a century ago, all civilized nations were paying tribute to the Barbary States on the Mediterranean coast of Africa. Attention is called to the influence upon naval construction of such epoch-making events as the battle between the *Monitor* and the *Merrimac;* and consideration is given to the effect that brilliantly fought naval battles have upon character.

The work is divided into thirty short chapters, beginning with the organization of the first navy during the opening months of the War of the Revolution, and carrying the reader through that war, the war against the African pirates, the brief war with France, the war of 1812 against England, the civil war in the United States, and the war with Spain. Owing to the great range of operations during the war of 1812 and the civil war, these are, of course, given most extensive treatment, and the illustrations covering ships, battles and commanders are especially interesting.

The Gas Engine. By Frederick R. Hutton, E. M., Ph. D., Sc. D. Size, 6 by 9 inches. Pages, 562 + xx. Figures, 241. New York, 1908: John Wiley & Sons. Price, $5. London: Chapman & Hall, Ltd. Price, 21s. net.

This is the third edition of a treatise on the internal combustion engine, using gas, gasoline (petrol), kerosene (paraffin), alcohol or other hydrocarbon as a source of energy. The work is divided into twenty-one chapters, the first four of which are devoted to theoretical and practical considerations regarding heat and energy, and the heat-engine cycle. These comprise nearly one-third of the volume. The next four chapters deal with engines using the various types of fuels, these chapters being descriptive, in large measure, and illustrative of the various types. The other chapters cover such subjects as the proportioning of mixtures, carburation, ignition, governing, the cooling of the cylinder, the treatment of the exhaust, the manipulation of gas engines, their performance and tests, theoretical analysis of the gas engine, experiments, costs of operation, etc. The most extensive chapter of all is that covering the theoretical analysis, this being not less than 139 pages, or practically one-fourth of the volume.

In this work, in general, the treatment of the design of engine parts has been omitted, partly because of the extra bulk which would have been entailed in the book, and partly because of the recent appearance of a book upon gas-engine design, by Professor Lucke. The descriptive material, however, is complete, and a considerable amount of information which would naturally come under the head of design is here included. The treatment of mean effective pressure, of efficiency, of the guarantee, and a discussion on the producer-gas engine, and on alcohol as a fuel, are new features of this edition. The value of the analysis of the different cycles under which various types of gas engines operate is also increasing, as more attention is paid to these matters by engineers in general.

The illustrations are mainly of the line type (principally wax cuts), but a few half-tones of typical engine installations have been incorporated, some of them in the text, and others on insets. Ten pages at the rear of the book have been devoted to a very complete index, just previous to which are three pages covering a table of hyperbolic logarithms.

Fighting Ships, 1907. Edited by Fred. T. Jane. Size, 12 by 7½ inches. Pages, 500. Numerous illustrations. London, E. C., 1907: Sampson Low, Marston & Company, Ltd. Price, 21s. net.

In many respects the most complete naval publication to be found is the present volume, the compilation of which must have represented a tremendous expenditure of energy. The general scheme is somewhat similar to other annual works of the same sort, in which there are published side by side information regarding the various warships of the several powers, and sketches showing the general distribution of the battery and armor, the masts, funnels and other parts of the ship. This work, however, goes much farther than this, in that it includes also reproductions of photographs from at least one in every type of completed ship, and differentiates in minor points as between ships of the same type or class, so as to enable the different vessels to be readily recognized at sea. The amount of information contained, and especially of detailed information regarding the principal military features of the ships, is extremely great, and, as the work is undergoing continual revision, it is very improbable that any serious errors can have passed through the editor's hands. The various guns and items of armor protection are classified according to arbitrary standards, so that it is quite possible to compare with considerable satisfaction guns of different types in the different navies. In many cases the weight is given of the armor as a whole, while in some cases the weight of battery with ammunition is also given. The comments running through the entire work are especially valuable as indicating points which are not generally known, such, for instance, as the loading positions of the big guns, and the amount of ammunition carried per gun.

In addition to the extremely complete list of ships, with photographs and diagrams, there are silhouettes of most of the important war vessels, as well as some of the principal ocean liners, which might, on occasion, be impressed into service as auxiliary cruisers. These silhouettes are, of course, taken from directly abeam, and in each navy are classified according to the arrangement of funnels and of masts, these being, of course, the most conspicuous features of a ship when seen at a distance.

The second part of the book includes a number of chapters, or essays, devoted to various naval subjects, such as new warship construction, which is a résumé of naval construction within the past few months; programs of new construction; notes upon battery and armor; tables showing the numbers of ships in the principal navies fitted with guns capable of penetrating armor at a distance, and the ships with belts of considerable thickness, and fitted to withstand the attack of heavy projectiles. Warship Engineering includes tables of all warships fitted with turbine engines, and diagrams showing the arrangement in certain special cases. Following this are diagrams of the various principal types of boilers, information on steering gears, coaling at sea, and various auxiliary devices for use in the engine room. The boilers are given some considerable attention, a brief description being given of each of about a dozen different types. The British naval maneuvers of 1906 are treated in some detail, and the work ends with a list and silhouettes of all merchant liners of over 5,000 tons gross belonging to the different merchant fleets of the world, and classified according to nationality and to location where usually found.

In the preface attention is called to the fact that each ship is treated entirely on one page in the book, and that not only the silhouettes and diagrams have been kept thoroughly up to date in connection with changes continually being made in all of the fleets of the world, but also recent photographs of warships have been substituted in very many cases for older ones. In treating of the various battleships of the latest types, it is stated that few if any warships are likely to be built in the future which cannot use all their heavy guns on one broadside. "America in the *South Carolina* led the way in this direction, and the ship of the future is bound to be some improved variation of her.

"In the agitation now proceeding as to the relative superiority of the British fleet, it is somewhat curious that the points tabulated," with regard to the vessels carrying heavy armor-piercing guns, and those carrying waterline belts safe against various guns at more than 4 miles range, "have been little discussed. These tables omit all ships projected in 1907-1908 programs. Such figures would slightly increase the United States superiority in long-range attack. The extremely high figures for the United States ships afford food for considerable thought; for both in ships with high powered guns and in ships impervious to vital injury at long range the United States fleet is superior to any other navy in the world. Even by the inclusion of 40-caliber 12-inch guns of types extinct, so far as new ships are concerned, the United States is an extremely good second, and the corresponding lead in invulnerability outside 7,000 yards is considerably increased." A small table shows that with the 12-inch 45-caliber guns, or the equivalent, the United States and Japan have each twelve ships built and building, while England and France have ten each and Germany six; including the 40-caliber guns Britain leads with forty ships, followed by the United States with thirty-four, France with twenty-seven, Japan with twenty-six and Germany again with six.

Lake Shipyard Methods of Steel Ship Construction. By Robert Curr. Size, 6 by 9 inches. Pages, 172. Figures, 187. Cleveland, Ohio, 1907: The Penton Publishing Company. Price, $2 (8/4).

This is largely a reprint of articles which appeared during 1907 in *The Marine Review*. It is very profusely illustrated, and gives detailed information as to the methods of construction by which such remarkable results have been achieved by the shipbuilders on the Great Lakes. It is devoted largely to a description of the mold system now almost universally in use on the lakes, by means of which the entire vessel is laid out, practically before the assembling of the different parts begins. In particular, the shell plating is all laid off in the mold loft, and the plates, as cut and punched, are so marked as to make identification easy as soon as the construction has proceeded to such a stage as to require any given plate.

The work is in twelve chapters, covering respectively laying off, bulkheads, molds, stern plating, expansion of plating, keel and center keelsons, bow framing and plating, engine foundations, deck houses, masts, the erection of material and the advantages of mold work. Most of the illustrations are sketches showing the methods of joining together the various parts of the structure, as well as the methods of laying them out. A few half-tones are used to illustrate various operations under way, and to show some of the methods by which the work is carried out. The book seems to be a very complete exposition of the methods in use on the lakes, and as such should prove a valuable aid to designers, and to any others interested in this subject.

Annual Report of the (Japanese) Mercantile Marine Bureau for 1906-1907. Size, 7¼ by 10¼ inches. Pages, 135 + v. Tokyo, 1907: Published by the Department of Communications.

This is largely a book of tables covering the shipping and shipbuilding of Japan, with statements showing the total number and tonnage of vessels at the end of 1906, the classification of registered vessels of various types, the shipbuilding establishments and their operations during the year 1906, casualties, life-saving equipment, certificates and licenses, entrances and clearances of shipping at the open ports, lighthouses, encouragement given by the government to shipbuilding

and ship owning, in the shape of subsidies, and various other items of kindred nature.

The merchant marine of Japan, at the end of 1906, is stated to have included 2,103 steamers of 1,041,569 gross tons, and 4,547 sailing vessels of 354,356 gross tons, besides 22,632 junks. The number of vessels entering and leaving the four open ports (Yokohama, Kobe, Nagasaki and Moji) was 57,825, of an aggregate of 83,304,133 gross tons. This includes both ships entering and ships leaving, and includes also the coastwise traffic. Examination of the tables shows that Kobe was the largest port, with 15,220,566 tons entered, and a slightly larger tonnage cleared. Moji stands second, with Yokohama and Nagasaki following. If we omit coastwise traffic, Moji stands first, with 10,311,653 tons entered, and about the same amount cleared; with Kobe second, and the other two ports following.

Navy Year Book. Compiled by Pitman Pulsifer. Size, 5⅝ by 9 inches. Pages, 643. Washington, 1907: Government Printing Office.

This book is a compilation of all of the annual naval appropriation laws of the United States from 1883, when the first steel vessels of the so-called "new navy" were authorized, up to, and including, 1907. The first 570 pages of the work are taken up with verbatim reports of these various laws, forming a splendid volume for reference in connection with appropriations for the construction of ships, their armament, armoring and equipment, their maintenance, and all the various items of expenditure of a large sea-going naval establishment.

The next 39 pages of the book are devoted to tables, showing the naval appropriations for the various years; an alphabetical list of all war vessels authorized during the years in question, this list showing the name, type, displacement, speed, draft, contract price of hull and machinery and the date of authorization. The next set of tables lists by years the various ships authorized, and gives the same particulars regarding them as in the preceding table. This shows that during the years in question there have been authorized no less than 170 ships, of a total of 754,762 tons displacement. Next come tables showing the actual total cost of each completed ship of over 2,000 tons displacement, with a statement of the expenditures up to June 30, 1907, on vessels under construction. This table shows that the most costly vessel in the navy at present is the *Connecticut,* with $7,667,607 (£1,575,590). One other, the *Kansas,* is over $7,000,000 ($7,071,143, or £1,453,025), while the armored cruisers are of approximately the same cost per unit as the battleships. The most inexpensive of all the battleships of over 10,000 tons was the *Illinois,* at $4,621,409 (£949,637).

Next come tables showing under the several vessel classifications the number and displacement of warships built and building for Great Britain, United States, France, Germany, Japan, Russia, Italy and Austria, with tables showing the dates, names, displacements, batteries and speeds of all the battleships and armored cruisers built and building for these eight powers. Another table gives the time of building battleships for the United States, the longest period having been 5 years 5 months and 12 days for the *Ohio* of 12,500 tons; and the shortest, 2 years 9 months 13 days for the *Vermont,* of 16,000 tons. The average for the twenty-two vessels completed at the date of the report was 4 years 0 months and 22 days. In each case this comprises the interval between the laying of the keel and the date of first commission.

The French cargo steamer *La Rance,* which we described last September (page 371), and which is fitted with Lentz valve gear and Pielock superheaters, has shown a coal consumption of 0.408 kilogram (0.8995 pound) per horsepower per hour, as compared with 0.511 kilogram (1.127 pounds) for her sister ship *Garonne,* fitted with "ordinary" engine and boilers. *La Rance* developed 1,690 horsepower, as compared with about 1,430 for *Garonne.*

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 399.—Will producer gas work as well with two-cycle engines as with four-cycle engines? A. L. H.

A.—A two-cycle engine could be designed, in such a manner that the charge of gas and air could be forced into it under a few pounds pressure by a positive blower, that would work to perfection. The objection to the two-cycle engine for use with producer gas applies only to that type which uses crank-case compression. It is probable that the gas, which carries considerable sulphur and carbonic acid, would corrode the brass-work, composition boxes, etc., and affect the oil in the crank case. Besides, with the suction producer, it would have to draw its charge of gas and air under some five or six ounces of vacuum in some cases, which would cut into the power of the engine. I have never tried this two-cycle engine, and these objections may not be as large as they seem. H. W. T.

Q. 400.—With an eccentric sheave 15 inches in diameter and a 5-inch throw, and the engine on dead center, the sheave is moved ⅛ inch on the shaft. How much does it move the valve? The size of shaft is not known. T. M. C.

A.—Assuming that the valve has no lead, the eccentric will be approximately at right angles to the position of the crank, and the virtual position of its center will be practically in a horizontal plane containing the center of the shaft. A movement of the sheave on the shaft of ⅛ inch would produce in the valve a movement of (⅛ inch times the cosine of the angle between a vertical through the center of shaft and the virtual valve rod). As the length of this rod is very great in comparison with the 5-inch throw of the eccentric, the value of this cosine would be almost unity. We may say, then, that the movement of the valve would be only an extremely small fraction less than ⅛ inch.

The size of the shaft has no bearing on the matter, because the eccentric is moved always in such a way that its center traverses a circle the diameter of which is 5 inches, or the throw of the eccentric, and this is the figure which would be used in such a computation. If, as customary, the valve has a lead, the eccentric would not be approximately at right angles with the crank, and the extent of this lead would have to be known before a computation could be made. This would considerably alter the solution, reducing the movement of the valve for a given movement of the sheave.

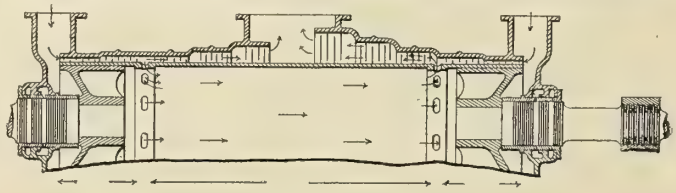
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

874,356. MARINE TURBINE. EDWIN C. CARNT AND ANDREW FORSTER, EAST COWES, ISLE OF WIGHT, ASSIGNORS OF ONE-THIRD TO J. S. WHITE AND CO., LIMITED, EAST COWES.

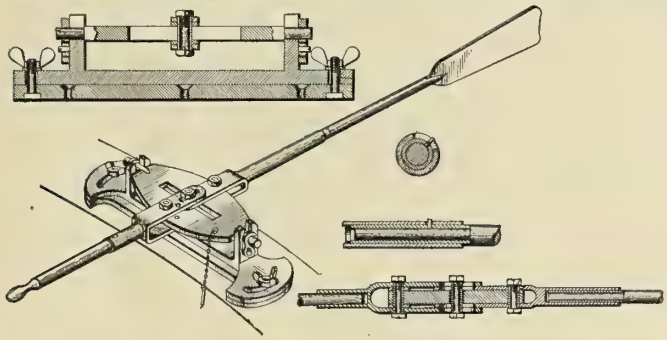
Claim 1.—A parallel flow single drum marine turbine oppositely bladed at the steam entry part, thereby constituting a self balance, and bladed at the remaining part in opposition to the propeller thrust, and the whole interior of the drum of which turbine is in communication



with the outlet ends of the blading of the self balance and the inlet end of the blading of the propeller balance, and constitutes a passage for steam from one to the other. Two claims.

874,317. BOW-FACING OAR. HENRY FLINT, ST. LOUIS, MO.

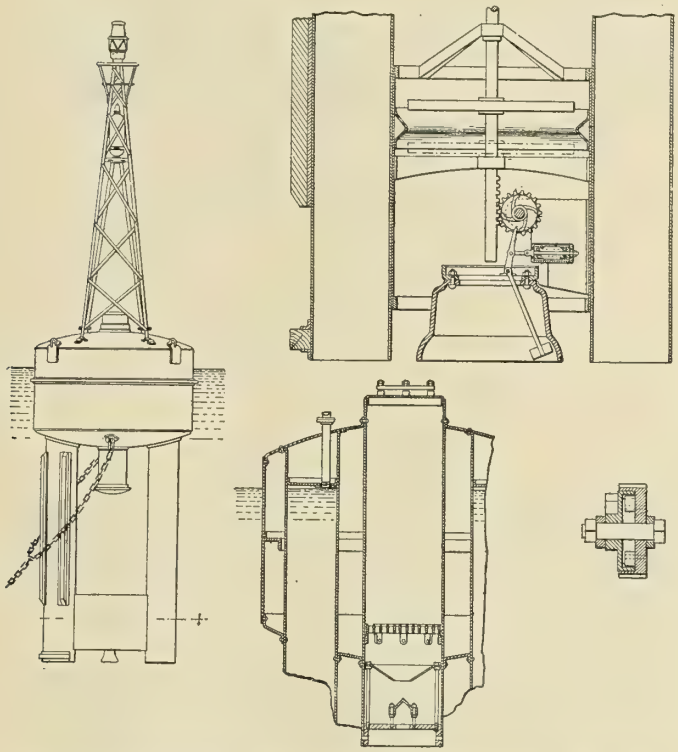
Claim 1.—A bow-facing oar composed of two sections, a slotted tilting plate, each section pivoted on a line central to the slot, and so



fulcrumed as to move both sections in the same direction, so that a boat can be propelled in the facing direction of the oarsman by a pulling motion. Three claims.

874,646. BUOY. THOMAS L. WILLSON, OTTAWA, CANADA, ASSIGNOR TO UNITED STATES MARINE SIGNAL COMPANY, JERSEY CITY, A CORPORATION OF NEW JERSEY.

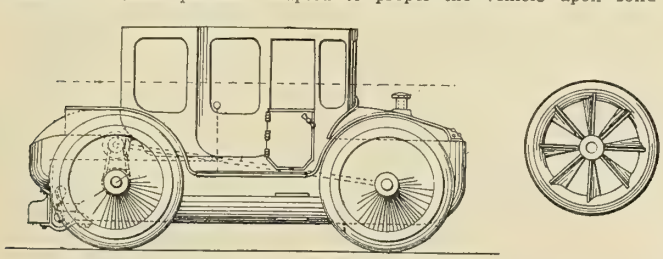
Claim 4.—A whistling buoy having a whistle, two air compressor tubes operating the whistle and diametrically opposite each other, and



mooring chains attached fixedly to the buoy and extending in the direction of the plane of the two tubes, so as to hold the edge of such plane to the current. Eight claims.

875,210. CANOE CARRIAGE. JULES J. RAVAILLIER, PARIS, FRANCE.

Abstract.—The invention comprises generally a vehicle body having a lower or base portion in the form of a boat, and supporting wheels provided with tread portions adapted to propel the vehicle upon solid



surfaces, and having propelling means for navigating the vehicle in water. The forward wheels are connected with suitable steering apparatus for guiding the vehicle on land, and said wheels are also adapted for guiding the vehicle in water; and suitable motive power is provided in the vehicle for driving said wheels. Six claims.

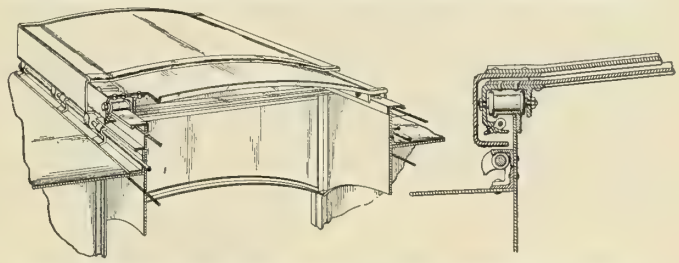
875,199. CONVEYING APPARATUS. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim 2.—In a conveying apparatus, in combination, an outgoing

rope, an incoming rope, an engine whereby they are moved inversely, stops on one of said ropes and a load carriage engaging said rope between said stops, and also engaging the other rope. Thirteen claims.

875,734. SHIP'S HATCH. JOHN REID, NEW YORK.

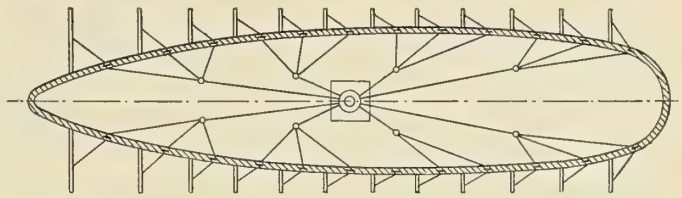
Claim 1.—In a ship's hatch construction, the combination with suitable supports projecting upwardly from the sides of the hatchway, of



a cover traveling along said supports, a cover adjoining the aforesaid cover and arranged in a higher level, means for raising and supporting the upper cover, and means for causing the lower cover to travel along said supports under the higher cover. Nine claims.

875,752. DEVICE FOR RETARDING AND STOPPING THE MOTION OF SHIPS. EUGENE P. A. VILLETTE, LILLE, FRANCE.

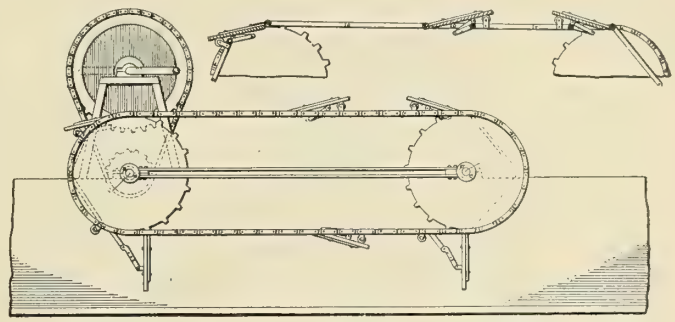
Abstract.—In each side of the ship and according to the height of the same (from the keel to the waterline) are provided spaces to admit iron plates which partake of the form of paddles, though such form may



be varied. The plates are movable and rotatable on hinges secured to the side of the ship. Further, the plates are provided with a maintaining rod, located in the center of the plates for instance, and connected to the driving device located in the ship. Two claims.

876,133. MARINE PROPULSION. ALBERT E. BEEBE, MAYVILLE, N. D.

Claim 2.—A propeller comprising opposite sprocket chains, sprocket wheels receiving the same, cross-bars between the opposite sprocket chains, brace rods between the cross-bars in the direction of length of



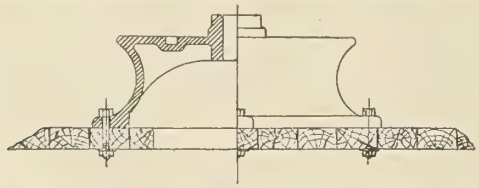
the sprocket chains, paddle blades pivoted to their respective cross-bars, stays made in sections pivoted together, and pivoted at one end to the paddle blades and at their opposite ends to their respective cross-bars, and stops for limiting the closing movement of the paddle blades and mounted on the brace rods. Four claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

19,106. LIQUID FUEL BURNERS. REGULATING OIL SUPPLY. T. CLARKSON.

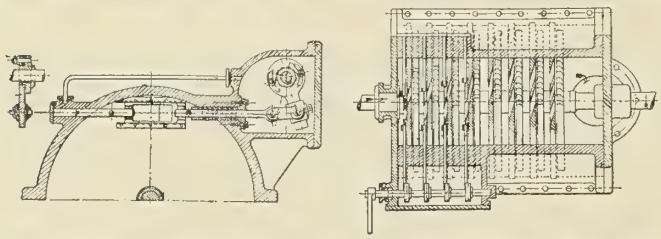
A thermostat, of the kind in which two metals having different coefficients of expansion are employed, actuates the valve controlling the supply of liquid fuel to the burners of a steam generator, through the medium of a removable rod having no appreciable expansion. This rod may be interchanged with others of different lengths, so that the temperature at which the thermostat comes into operation may be varied. The thermostatic portion comprises a tube fitting in an outer tube, through which circulates steam from the generator, and a rod supported loosely in the inner tube and of a different expansibility. A removable rod is interposed between the end of the first rod and the valve, and is preferably rounded at its ends.

17,591. CAPSTANS. S. RICHARDS, LOWESTOFT.
Relates to capstans driven from steam engines located on the top of the capstan, and consists in mounting them so as to permit ready access to the steam pipes passing up within the hollow spindle of the capstan.



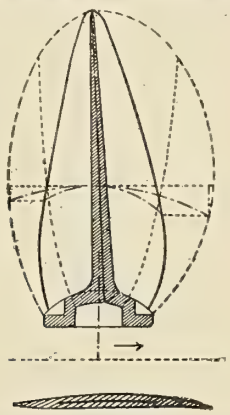
The elevating base is formed in one casting, preferably as a towing post or bollard. The underpart of this base is hollow, and is fixed over an aperture cut in the deck. The upper surface is fashioned as the pan having a central collar and passage for the pipes. Access may also be had to the interior through apertures in the bollard.

17,783. ELASTIC FLUID TURBINES. R. HADDAN, STRAND, LONDON, W. C.
Relates to adjustable valve regulating devices for the stages of multi-stage axial or radial elastic fluid turbines, adapted to allow the ratio of the nozzle openings in successive stages to be varied according to the load. As applied to a parallel-flow turbine with eight stages, the nozzle openings of the first four stages are regulated by slide valves connected by an adjustable device to a shaft, which is operated by hand or by a governor. The slide valves are worked by valve rods, each of



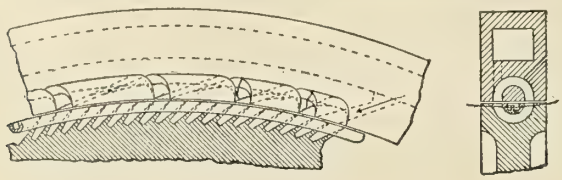
which is connected at one end to a rocking lever, which is fixed by means of an adjustable pin-and-slot device to a disk fixed on the shaft. The rocking levers are adjusted so that the ratio of the nozzle openings is varied according to the load, a light load requiring a high expansion ratio, and a heavy load a low expansion ratio. The slide valves may work on roller bearings either smooth or toothed. The valves may be formed as rocking sectors, with one or more ports, or as rocking cylindrical valves, or as slide valves operated by rocking slotted levers and having one or more ports. The valves are preferably balanced. The details may be otherwise modified.

17,802. SCREW PROPELLERS. G. RABBENO, SPEZIA, ITALY.
The blades are formed of two sheets of metal with an intermediate space, and united at their edges only by being cast solid. The object



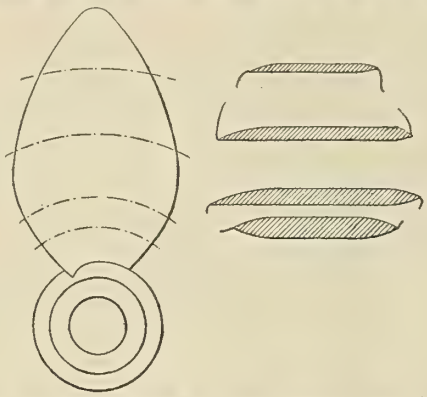
is to render the blades more flexible. In a modification, the laminæ are brazed together. Small propeller blades may be made by flattening a hollow cylinder of metal by pressing it upon a series of molds.

18,145. ELASTIC FLUID TURBINES; IMPACT WHEELS. R. J. HODGES, DEVONSHIRE SQUARE, LONDON.
Relates to the type of impact wheel in which the steam is caused to take a spiral path about the periphery of the rotor. Three methods of forming the buckets are described; a semicircular groove is turned in the periphery of the rotor to enable the buckets to be milled. The groove is afterwards filled by a split ring, which is sprung into place and then secured by soldering, etc., and by wire wound upon it under tension. In a modification, the bucket walls may be integral with the split ring, which is secured in the same way. In another construction the bucket walls are all separate, and are held in position by a ring. The spiral redirecting passages increase in width from the nozzle by the pitch of the buckets. A space equal to the pitch is also left between the



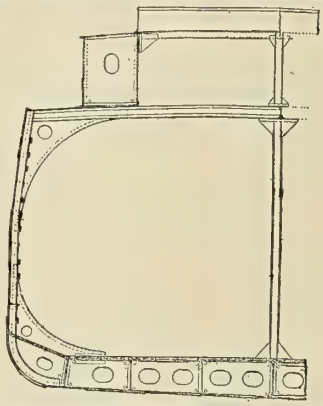
redirecting passages. Several wheels may be arranged in series on the same shaft.

18,012. SCREW PROPELLER. G. QUICK, ROSEHILL, BOURNEMOUTH.
The blades are constructed with their leading edges of double bevel or chisel shape, the angles of each side of the edge being preferably



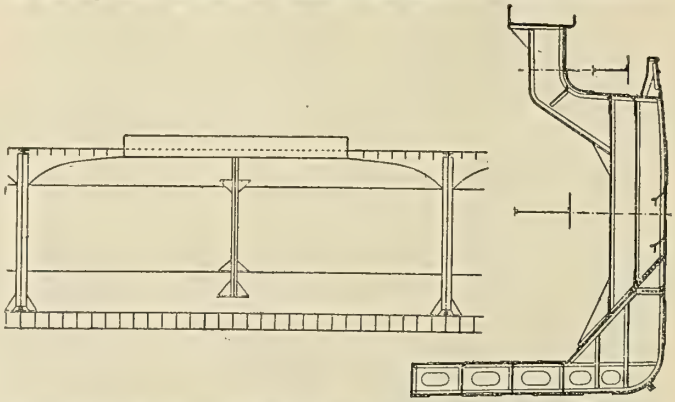
equal. From the leading edges to some distance past the mid-length of the blade, the thickness of the blade is uniform, and then gradually decreases in thickness to the following edge, as shown in the sections. This construction insures that both faces of the blades are of the same pitch, and that the thickness of the blades is uniform at the same radius.

18,833. SHIPS' TANKS; FRAMING. E. H. O. R. ROPNER, STOCKTON-ON-TEES.
Vessels of the trunk type are provided at each side of the trunk with water ballast tanks formed of the side of the trunk, the deck, the lateral extension of the trunk deck, and a wall intermediate of the trunk side and gunwale. The tanks are fitted with web plates spaced through-



out the whole of their length. Web frames support the tanks, and are connected to the double bottom. Portable or fixed pillars may be fitted, but, when dispensed with, diagonal pillars are fitted between the sides of the vessel and the under sides of the tanks. Cross pipes or passages may connect the tanks. The tanks extend the entire length of the cargo holds, stopping at or about the forward and after bulkheads, or they may be fitted for only a part of the length of the vessel, and may be applied to vessels having sloping decks or sloping trunk sides.

18,922. SHIPS' FRAMING; TANKS; DECKS. H. BURRELL, GLASGOW.
Cantilever webs, constructed of plates suitably stiffened, are connected by brackets to the sloping bilge tank, and support the ship's side and upper structure. In conjunction with the webs, cantilever brackets, built out from the bulkheads, support the central portion of the top deck, so that the whole of the ship's structure is supported



without the aid of stanchions or beams in the cargo space. The deck plating is pierced by a series of small openings, to facilitate the passage of grain into the hold below. When the sloping corner tanks are used in conjunction with ordinary floors, the floor plate is connected to the lower boundary plate by lugs, and the lowest strake of the tank plating is extended beyond this boundary plate so as to cover the end of the floor.